THE

POPULAR SCIENCE MONTHLY.

JULY, 1882.

PLANT-CELLS AND THEIR CONTENTS.*

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A CHILD'S toy-balloon may afford us an illustration of what a naturalist might call a typical cell. We have in the toy simply a closed sac thoroughly distended by its contents, more or less perfectly spherical in shape, and affording in outline or cross-section an almost perfect circle. In the organic cell the sac is known as the cell-wall, and whatever may be inclosed by the cell-wall is called the cell-contents. A typical cell would be round, spherical, but very few cells, as they occur in nature, are perfect spheres. A cell which may be spherical at the outset may change its shape in accordance with changing circumstances, so that we may say that the form of all cells which we find united to form tissues varies with the situation which such cells occupy, and the functions of the tissues themselves. This we shall see more clearly as we go on. That vegetable tissues, as they occur in wood, pith, leaves, flowers, and fruit, are entirely composed of cells, may be easily demonstrated. All that is needed is, to take a very thin slice of any of these substances and examine with a microscope of moderate power, when the cellular structure becomes immediately apparent. So, then, all the great variety of form and color, and all the resulting beauty, which the vegetable kingdom affords, and all the varied economic value of plants, depends upon the form and contents of these little organic units—of cells. More than this: these cells are of the highest scientific interest. All the discussion of the past few years in regard to spontaneous generation and the origin of life has been a discussion of vegetable cells; and very much of all that we know about life, its activity and its mystery, has been derived from

* Illustrations from drawings by C. H. Dayton, Mary McBride, and the author.

the study of the cells of growing plants. It becomes, then, a matter of some interest to know something about these cells; and, if the reader can imagine himself for a little while looking through the lenses of our microscope, it will be the purpose of this article to tell him some little of what he may see while he studies the cells of plants.

We may begin with the simplest form of plant-cells; and so, for our first experiment, let us examine a drop of brewer's yeast. Here (Fig. 1) are the cells of the famous yeast-plant, the cells which are the active agents wherever yeast is employed, whether in the beer-vat or batter-crock. In both cases we find the cells producing fermentation: desirable in beer for the sake of the alcohol resulting; in bread, for the carbonic gas set free in form of bubbles, which, permeating the dough, make it spongy and light. But look at the shape of these cells. Little oval bodies they are, some almost round. Many are entirely isolated, so that we see a single cell may constitute the entire plant; some are linked together, as links in a chain. The attachment here, however, is not very intimate, when once the cells have attained their full size, for then each cell readily and naturally parts company with its neighbor—parent, I should rather say, for the cells, as they adhere together, represent really so many successive generations, and illustrate for us one method of cell-multiplication, namely, that which is effected by budding. New cells are continually pushed out as buds on the sides of cells already in existence. The buds grow, reach maturity very rapidly, and in a very short time themselves give rise to new buds and cells. These little yeast-cells, which are not more than three or four ten-thousandths of an inch in diameter at most, are about as simple vegetable cells as we may find anywhere. Growing thus isolated from each other, hardly so much as jostling one another in life's race, there seems no reason why such cells should not be perfectly spherical, or why, so to speak, life's work should not, with them, result in a well-rounded whole.

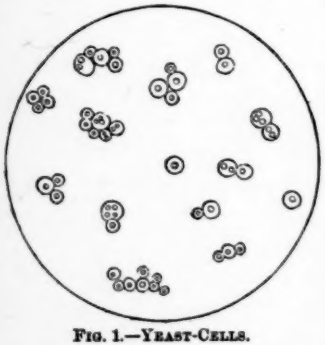

FIG. 1.—YEAST-CELLS.

But the yeast-plant belongs low down in the scale of life, and its simplicity of cell-structure corresponds well with its rank. For the greatest variety of form among plant-cells we must look to higher plants, though not to the highest. The *Algæ*, in their marine forms well known to every gatherer of "sea-moss," and in fresh-water forms familiar to all microscopists, afford cells of almost every imaginable shape, character, and color. Here, as with the yeast-plant, a single cell ofttimes makes up the entire organism, but, while some cells are simple, others branch and divide in all directions: some simulate the

stem, roots, and branches of higher plants, some are tiniest rolling spheres; some stretch away to the length of several feet, and some are microscopic specks. In Fig. 2 we have the representation of a beautiful marine alga, unicellular, and yet thirty inches or more in length.

As we ascend the scale of life we find the individual cell more subordinate to the organism as a whole, and so less complex in itself; and

FIG. 2.—UNICELLULAR ALGA (copied from Thomé.)

yet, when we examine the cells which make up the tissues of the best plants we can find, the blooming occupants of our hot-houses, gardens, and fields, we meet with marvelous diversity, and are soon made to feel that variety of form is the law, uniformity the exception. Fig. 3 represents the appearance of a cross-section of a stem of *Tradescantia*. From this section we may learn not the variety of cell-forms only, but something of the manner in which every plant is developed, and something of the porousness of all cellular structure.

But let us tear off with our forceps a little shred of the epidermis of some leaf. The leaf from a petunia will do; that of the wild Jacob's-ladder is better, and that of the wake-robin better still. Let

us examine this little shred with our microscope, using a lens of moderate power. This is from the upper side of the leaf (Fig. 4). How delicate the cell-walls, how beautiful the pattern! Here is Nature's best attempt at uniformity. All these cells serve identically the same purpose, and, so far as we can see, might have been exactly alike. Yet, while there is similarity, no two are just alike. Let us tear off another shred of epidermis, this time from the lower surface of the

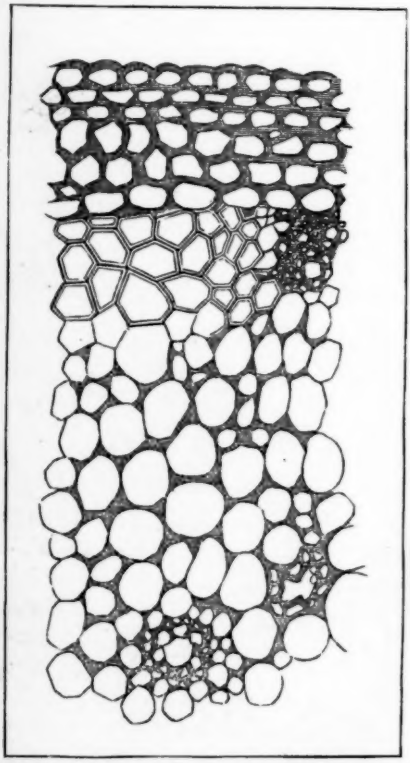

FIG. 3.—CROSS-SECTION OF TRADESCANTIA ZEBRINA, WANDERING JEW (highly magnified).

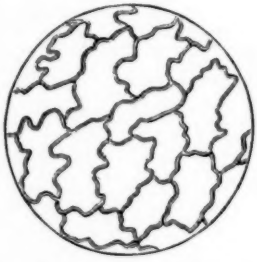

FIG. 4.—EPIDERMIS FROM THE UPPER SIDE OF A LEAF.

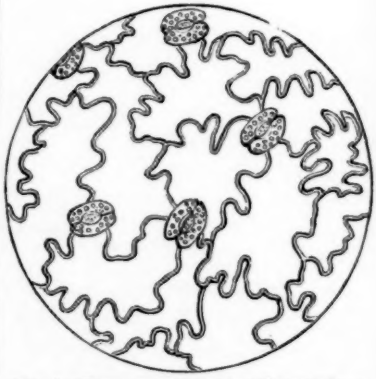

FIG. 5.—EPIDERMIS FROM THE LOWER SIDE OF A LEAF.

leaf. Here (Fig. 5) we have the same arrangement and forms of cells, but more beautiful and varied outlines, and the cells are more intimately interlocked. Our magnifying power is greater, and the cells appear larger; moreover, we have before us a few cells altogether unlike any of their neighbors, little button-hole-like structures. These are the stomata of the leaf, and through these tiny *mouths*—for the stomata are real openings through the epidermis—the exchange of gases goes on between the growing plant and the surrounding atmosphere.

Let us now pass on a little further in our investigation of these plant-cells and note the contents of some of them. In our examination

of the cells from the epidermis of the leaf no contents were apparent; in fact, the cells are tabular, very thin in proportion to their width, and any contents they may possess are so nearly homogeneous as to be transparent and invisible. But let us make a thin transverse section of the same leaf. Here (Fig. 6) we find cells different in shape from any we have yet seen, and evidently possessing different contents. The cells from the inside of the leaf are here seen filled with tiny green bodies, sometimes closely packed together, sometimes scattered more sparsely. These little green bodies are the *chlorophyl*-granules, affording to our vegetation all the lovely tints which render charming a landscape in spring. Children of the light are these little green grains, lovers and worshipers of the sun. At all events, they appear by uncounted millions in the bright light of the open sky, become fewer and fewer in proportion as the light received by any plant is diminished, and finally disappear entirely when the plant is left in total darkness. Every one will recall the appearance of potato-stalks where growth has started in some dark corner of the cellar. Cells taken from such growth afford not a sign of chlorophyl. Botanists tell us that the petals of flowers are only altered leaves. In petal-cells, then, instead of chlorophyl-grains, we find in some cases granules of yellow, sometimes of orange. Sometimes the cell contains no such granules, but rather some colored fluid, red, blue, or purple, and then our flowers are tinted accordingly; sometimes the cells of a petal contain air only, and then the flower is white.

FIG. 6.—CROSS-SECTION OF A LEAF, SHOWING THE CELLS CONTAINING CHLOROPHYL.

But these tiny green grains in the leaf-cells do vastly more than simply lend their color to the foliage; they are readjusters and organizers, and perform, in those diminutive laboratories we have been calling cells, feats which the chemist strives in vain to rival. They take possession of molecules of carbon dioxide and of water, compel the binding chemical forces to relax their hold, combine again, to serve the purposes of the plant, the atoms of carbon, of hydrogen, using such part of the oxygen as may be necessary, and setting the remainder free in the open atmosphere—all this in the sunlight. The chlorophyl bodies thus work while it is day, have charge of nearly all the income of the plant, and provide in themselves for the temporary storage of its daily accumulations, mostly in the form of starch. When the night comes, these same little factors give up at once their labors and their stores, other cells of the plant begin to work, change and transfer and change again, until all the wondrous series of vegetable products with which we are familiar (the sugars, the oils, the alkaloids, crystals of various forms and kinds) are formed and properly deposited. We might go on now to examine cells containing many of these sub-

stances, but one or two examples will suffice. Perhaps the most familiar vegetable product is starch, certainly interesting since it enters so largely into the daily food of the world. Let us make a thin section of a common potato and examine it for a moment (Fig. 7). See what a multitude of tiny spheres and ellipsoids crowd the cells! If we apply to our section iodine, we introduce the test of color. The little solids take on a bright-blue tint, and so prove themselves

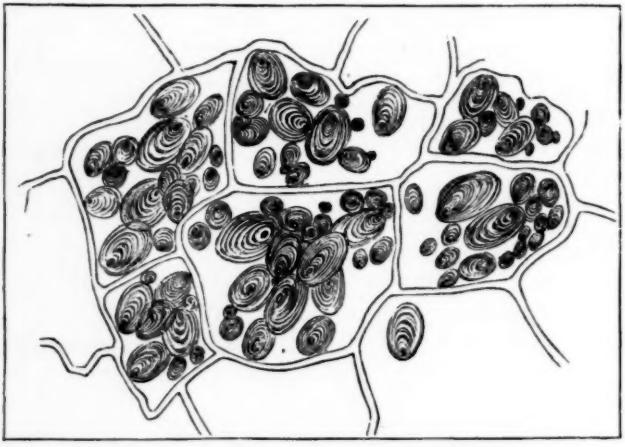

FIG. 7.—POTATO-CELLS, CONTAINING STARCH-GRAINS.

starch. Now we can *see* why the potato forms so nutritious an article of diet. During fall and winter starch-grains, such as we have just seen, fill the cells of apple-twigs and of branches of various kinds, and form the basis for that lavish expenditure of plant-force by which our orchards and woods are made glorious in the sudden inflorescence of spring.

If we make a section of the petiole of a begonia-leaf, we may find cell-contents as remarkable as beautiful. Here are plainly crystals with their symmetrical, angular outline. Some of the mineral substances brought through the plant by currents ascending from the roots have found room in the cells of the leaf-stalk to shoot the rays of minute crystals, and here the crystals lie, sometimes a dozen jewels in a single setting (Fig. 8).

But the interest attaching to plant-cells does not culminate in chlorophyl, nor yet in starch-grains and crystals. The chlorophyl, as we have seen, owes its allegiance to the light, the starch to the chlorophyl, and the crystals to the water and the soil; but back of all this, and behind all this, though intimately united with it all, is that which owes its homage to none of these—which moves all, controls all, uses all, builds the cell-wall, and inhabits it—is, indeed, the active principle by which chlorophyl becomes efficient, by which the inorganic is lifted

into forms organic, and the earth filled with the children of life, the very essence of the living cell—the *protoplasm*. To this protoplasm we now turn our investigation.

Twelve or thirteen years ago this word—the name, to say nothing of the thing named—would have come all but unknown to the general reader. But to-day, thanks to the continuous discussions of the last decade, the word needs no introduction. All our readers know that

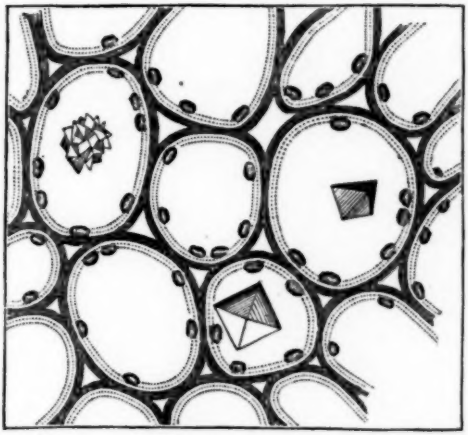

FIG. 8.—CROSS-SECTION OF PETIOLE OF BEGONIA-LEAF, SHOWS CRYSTALS IN THE CELLS (copied from Prantl.)

protoplasm is the simplest form of living matter with which we are acquainted, is the living element of every living cell. One of the most characteristic phenomena of life is independent motion, and protoplasm more frequently reveals itself by moving. Such is the case in the cells we are now considering. In 1869 Professor Huxley set the thinking world all agog by describing, in a passage of wonderful accuracy and beauty, what he could see of moving protoplasm in the hair of a stinging nettle. Nettle-hairs and vegetable hairs generally consist either of a single elongated cell, or of a series of oblong cells arranged in a filament. Moreover, such hairs, or *trichomes*, are usually colorless, transparent throughout, and afford, therefore, cells admirably adapted to microscopic examination. Hairy plants are very common, so we may corroborate Professor Huxley's statements by observations made almost anywhere. Let us examine a hair taken from the evening-primrose. Here, under a magnifying power of from 400 to 500 diameters, we may see within the hair a delicate current sweeping down one side to the point, turning abruptly with slight delay, and then returning by the opposite side of the cell, leaving in the center a neutral space filled with cell-sap, across which the oppositely moving streams seem never to pass, in which they are never lost. No nucleus is present, nor any central station of power. The tiny streamlet pours on, self-guided

(Fig. 9). The hairs on the young leaves of violets and on common red clover exhibit the same sort of a stream moving in much the same way (Figs. 10 and 11).

The unicellular hairs of the common morning-glory present a different phase of the same current. Here the stream is confined to the

FIG. 9.—TIP OF A HAIR FROM EVENING PRIMROSE.

FIG. 10.—TIP OF A HAIR FROM VIOLET LEAF.

FIG. 11.—HAIR FROM RED CLOVER.

FIG. 12.—HAIR FROM MORNING GLORY, UNICELLULAR.

cell-wall most closely, but the movement is unique. The protoplasm in its course is by turns contracted and expanded, giving to the whole current a billowy appearance, a miniature profile of rolling waters. Wave follows wave, but with no deceptive motion, for the rapidly passing granules advise us that the current is strong and real underneath waves that rise and fall but never break (Fig. 12).

The unicellular hairs found on young leaves of *Verbena urticifolia*, a common way-side weed, exhibit something like a nucleus at the base of the hair, from which center streams of protoplasm are constantly departing, to which they constantly return (Fig. 13). Fig. 14 shows the terminal cell of a hair taken from the petal of the purple lady's-

FIG. 13.—UNICELLULAR HAIR OF VERBENA.

FIG. 14.—HAIR FROM PETAL OF LADY'S SLIPPER.

slipper. Here the nucleus seems almost to be in the way. It is so large as nearly to close the narrow cell across from side to side, and the current appears crowded between the nucleus and cell-wall.

In the hairs that cover the common tomato-plant we may find beautiful transparent cells. In these cells sometimes the nucleus shows a vacuole, and the streams are always fine and large, but changeful as the shadows of passing clouds (Fig. 15).

But we must resort to plants belonging to the botanical order *Cucurbitaceæ* to find hair-cells showing greatest activity. In the hairs covering the forming bud of a common pumpkin-vine the cells are of

rapid growth, with finely transparent walls (Fig. 16). Each cell has a large nucleus, which, while variable and varying, is quite constant in position, and often shows one or more vacuoles. Out to the very limits of the cell, sweeping its every corner from the nucleus as a center, vital streams go forth—streams now wide and sweeping, now narrowing and again swelling, or pouring along to join some neighboring current; now forming temporary vacuoles, now bearing on strong tide

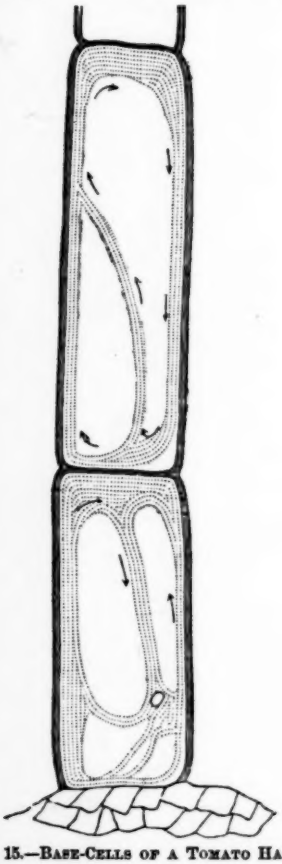

FIG. 15.—BASE-CELLS OF A TOMATO HAIR.

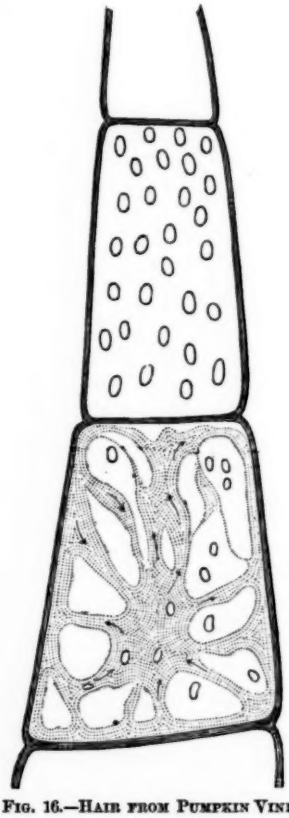

FIG. 16.—HAIR FROM PUMPKIN VINE.

particles large and small, granules of chlorophyl and what not; now branching in various directions, now diminishing to merest threads, forming and fading away, finally disappearing below the field of vision, only to reappear once more at the place of starting. The changes of movement and appearance are so rapid that no drawing can be true for more than a single moment.

In studies such as these we might pass on from plant to plant, in garden, on highways, in forest and on prairie, until time should fail and patience be well wearied. The "Song of Nature" is true :

"No numbers have counted my tallies,
No tribes my house can fill;
I sit by the shining fount of Life,
And pour the deluge still."

But there are some other plants whose cells exhibit the phenomenon of living, moving protoplasm so much better than nettle-hairs or pumpkin-hairs, that I can not forbear presenting, in concluding the present article, the cells of one more plant. The plant we now select is a very common one in most parts of our country, but on account of its simple and retired habits of life is little known save to the botanist and microscopist. An aquatic plant it is, finding a home in slow-running streams, or shallow ponds whose sandy bottoms reflect the warm rays of the summer sun. Totally immersed in water, however, and so far independent of rains, our plant knows little distinction of spring and summer, and grows on vigorously until the frosts of fall are heavy enough to seal everything under a covering of ice. If during this long, growing season we collect a sprig of *Chara* (for such is the name of the plant), we shall find it made up of something like a stem bearing whorls of leaves, or at least of what may pass for leaves. Let us now take one of the newest and smallest of these leaves and place it under our lens. A series of cells, you say. But through the thin wall of any cell appears again a flowing stream. Not the pale, delicate thread of silver we saw feeling its way around the cell-wall of the pumpkin-hair or tomato-hair, but a very river it seems now as it rushes on, wave after wave, up from the depths below across the field of vision and down again, over and over, or round and round, in ceaseless rotation (Fig. 17).

FIG. 17.—TERMINAL CELL FROM A FROND OF CHARA (slightly magnified).

Now the current catches in its course this little particle, now that, hurling each along, now up, now down, now over, now under, without weariness, without hindrance, hour after hour, before us.

And now, as the stream goes on so grandly, think, for a moment, what it is at which we gaze. We call it protoplasm, but it is the current of life, the "physical basis of life"—the common bond which binds in one the whole kingdom of organic things. Think, too, of the antiquity of that stream, its lineage. The brook that "goes on for ever" is as nothing to it, for here the stream has come flowing down through ages which are to us as eternity, ever since life began on earth. The mountains have been hoary with years, and have disappeared beneath the level of the all-producing sea, but this stream is older than they. Continents have grown old, worn out, and been re-

newed, rebuilt from the *débris* of this same stream, and life has again flooded the continents, but its origin is older than they.

But now that we have before us such a fine large stream, may we not make further investigation, may we not know its mystery, the hiding-place of its power? We touch the cell with our needles, open its wall to make minuter inspection; but in an instant the charm is broken, the mystic river forgets to flow, the tiny particles settle into unbroken peace.

"The parent fountains sink away
And close their crystal veins;
And where the glittering current flowed,
The dust alone remains."

We are permitted to look in and see how the work of life goes on, but we can as yet go no further. We may explain. We may say it is all the result of chemical forces, and doubtless chemical forces are working there; but such explanation demands an explanation. Does chemical action renew itself? Chemical action is one thing, chemical action perpetuated and controlled by life is quite another. We may say, life is the property of protoplasm, or we may reverse the statement and say that protoplasm is that form of matter which manifests the phenomena of life, but that is as far as we can go. The streamlet hemmed by the narrow walls of the cell of any plant is to us a boundary. On one side the line, peace unbroken, eternal fixity, rest, of a world whose chemical forces acted once and for ever; on the other, the vast procession of life begins, rises before us, spreads away in variety, activity, in beauty, in wonderfulness, incomprehensible.

THE JEWS IN EUROPE.*

By Dr. J. VON DÖLLINGER.

II.

A GLANCE at the changing fortunes of the Jews in France, England, and Spain, brings clearly to light how their condition was influenced by the hierarchy. In England as in Germany, the Jews were the special property of the king, and were in part fostered as a valuable and profitable possession, and provided with privileges, and in part, particularly under King John and Henry III, made the object of merciless extortion. They enjoyed, indeed, also the royal protection, which, however, in times of sudden attack by the populace, came almost always too late, and only sharpened the popular hatred to which

* Anniversary Address before the Academy of Sciences at Munich, delivered July 25, 1881. Translated by Mr. W. M. Salter.

they fell a prey. Henry III, after forcibly assessing them several times, took (in 1230) suddenly from them a third of their possessions; afterward, to get a loan, he mortgaged all the Jews of Great Britain to Count Richard. The Jews begged, since their condition had become unendurable, for permission to emigrate; but it was refused them, since the king loved them all too dearly to let them go. Bishops, as Grossetete, of Lincoln, demanded their banishment, and Edward I ordered it in 1290; and in this way robbed himself of a most valuable instrument, by which previous kings had indirectly taxed their subjects. On account of the general lack of regular and sufficient income for the crown—a lack under which all states at that time suffered—some persons must be found who would take the place of those who had been banished. Such substitutes presented themselves in the associations of the Caorsines and the Italian money-brokers. Their way to England was paved by the Roman curia, which used them as its collectors, though the most prominent of them became bankrupt suddenly in 1345, and went off with debts unpaid. As usurers and financial managers for the crown, they were hated no less than the Jews.

In France the system of extortion practiced upon the Jews was still more methodical and crafty. Philip Augustus began his reign at the age of fifteen (1182) with the plundering and banishing of all Israelites. The report that they put a Christian to death every year at the time of their passover is said to have led him to this course, but the debts left him by his father were the immediate occasion. In the year 1198 they were recalled. Louis VIII declared all their claims for interest to be invalid, and ordered that the moneys due them should be paid to their lords, the king and the barons. Louis IX, convinced equally that all taking of interest was heinous sin, and that all the Jews of the land were his slaves, compelled them several times to purchase the privilege of remaining in the country; and, when he thought that he had extorted enough from them, banished them from his kingdom, with confiscation of whatsoever they still possessed. When the Jews implored before the governor of Narbonne for the restoration of the rights that had been taken away from them by the king, they complained: "The Jews are robbed of their means, and yet compelled to pay their debts; while, on the other hand, those who owe them are freed from the obligation to pay their Jewish creditors. They are forbidden to loan money on interest, and yet are not allowed to earn a living in any other way." The king's order was not completely carried out. Many remained, others returned afterward from time to time.

Louis's brother, Count Alphonse of Poictiers, made use of a particularly shrewd procedure in his state, which was afterward imitated in Germany. Under the pretext of expenditure for a crusade, he had himself authorized by the Pope to appropriate to himself all interest

that had been collected by the Jews; and then the entire Jewish population, including women and children, was incarcerated. The poorer ones were liberated after a while; but the rich, with their wives, were held in prison until they had completely satisfied the avarice of the count and his officials. Philip the Fair did not fail to follow the example of his grandfather, in a way that was even more thorough, and brought more profit. He banished suddenly all Jews in the year 1306; possessed himself of their entire property; had their houses, synagogues, schools, and even their burying-grounds, sold to the highest bidders; and compelled all their debtors to pay into his own treasury. With the barons, who craved their share in the spoils, he came to an agreement.

The drama closed at last in the year 1394 when Charles VI, on the representation of his confessor, and at the request of his spouse, who was under this man's influence, ordered the last expulsion of the Jews from his kingdom, on the plea that many who had intercourse with them had become lukewarm (*tepidi*) in their faith.

In Spain, under Mohammedan rule, the condition of the hunted and afflicted people was more favorable than in any Christian land. Although not free, the synagogue chose its own national judges or kings to represent it before those in power. Their schools flourished there; they pursued especially the study of medicine with greater success than the Christians. Also under the Christian kings in the twelfth and thirteenth centuries they were still influential, serving the kings as financial advisers, chancellors of the exchequer, as astronomers and physicians. In Toledo alone there were some twelve thousand of them; their wealth permitted them to purchase at least the most indispensable rights by the expenditure of money. In general, from the time of the Arabian rule to the end of the thirteenth century, their condition in Spain was more favorable than in any other European land. Within the walls of their Jewish quarters (*aljamas*), they lived according to their own law and statute. But the fourteenth century brought evil in its train also to the Jews of the Peninsula. While valuable and serviceable to the kings as farmers of the taxes and chancellors of the exchequer, they were hated by the people. Now in one city, and now in another, they were attacked, struck down, and their synagogues burned. The most violent storm broke upon them in the year 1391, and raged throughout the whole of Spain; priests, like the Archdeacon of Ecija, had kindled the conflagration by their sermons. Many thousands were slain; 200,000 saved themselves by baptism, but after a few years it was found that 17,000 had relapsed into Judaism. A hundred years later—1492—the royal edict appeared which commanded the entire body of the Jews to emigrate, and leave their possessions behind them. Since the Inquisition at the same time forbade selling food to the Jews, the majority were not able to emigrate, if they wished, and so were compelled to be baptized. The most of

those who went out of the land—the numbers vary from 170,000 to 400,000—perished by plague, famine, or shipwreck. The descendants of the survivors, the Sephardim, found reception in Italy and in that part of the Orient which was under Turkish dominion; also for a short time in Portugal. Spain, however, became filled with families of mixed descent, and the contrasts of pure and impure blood, of old Christians and neo-Christians, poisoned the whole social life.

The fate of the Jews was still worse in Portugal than in Spain. For a long time their condition was better than in the rest of the Peninsula. The murderous storm of 1391 did not extend to them; they enjoyed some privileges, had property in land, and pursued agriculture and wholesale businesses. But in the reign of King Manuel (1495), otherwise praised as gentle and humane, they met with a deadly blow: their children under fourteen years were snatched from them and baptized; they themselves could remain in the land only as they became converted to the Church. Thus this kingdom also was filled with those who feigned conversion and were forcibly baptized. The results were fearful. In the year 1506, in Lisbon, two thousand new converts were put to death in three days, because one of the neo-Christians had ventured to doubt a supposed miracle. Soon after, the Inquisition was introduced as the well-tried instrument for handing over the property of the wealthy neo-Christians to the state treasury.

In the larger commercial cities of Italy, the existence of the Jews was, comparatively speaking, endurable. Since the trade in money was already in the hands of Christian bankers, they occupied themselves more here with mercantile business. They encountered no risings of the mob, or massacres.

All these things become more comprehensible when we observe that the historians of the time, in narrating the enormities that were committed, give no sign of pity, and do not utter a word of indignation. Many times the clerical chroniclers even express their satisfaction: for example, the Monk of Waverley writes in a triumphant tone of the massacre, in London, at the coronation of Richard I, which was perpetrated without any provocation on the part of the Jews, and closes with the exclamation, "Blessed be the Lord, who has given up the godless to their deserts!" ("Annales Monast.," p. 246). And yet they do not fail to point out that avarice was a principal cause of these misdeeds; that nobles and citizens who were in debt incited to them, in order, by a single stroke, to become free of their (Jewish) creditors; for money was in truth the protecting as well as the destroying angel of the Jews in those days. The unhappy ones must press their debtors, always expecting that at the next moment they themselves would suffer from the inevitable reaction against them.

Since the clergy declared the mere existence of the Jews among the Christians to be an immeasurable danger, requiring the most careful watching and isolating, we should expect that they would have

labored conscientiously and with all their powers to convert the Jews. This did not happen, however. The men who were capacitated for such a work were completely wanting until the beginning of the thirteenth century, and even after the rise of the mendicant orders, a part of whose work was to institute missions among the Jews, there was very seldom a theologian who could lay claim to the education indispensable to this end. An interpretation of the prophetical books (of the Old Testament), which could have made an impression upon educated Jews, was beyond the powers of that time. That great flood of allegorical interpretations, which ruled the Biblical literature of the Christians, appeared to Israelitish Biblical scholars the empty play of an arbitrary and unbridled imagination. The early Church stood, in general, much nearer to the Old Testament people and faith; the great alterations and new formations of the middle ages had immeasurably widened the gap. The worship of images, which, according to the Israelitish view, contradicted the Decalogue, the whole scheme of dominion and compulsion which had been organized by Hildebrand, the religious wars with the system of indulgences—these were things that made the conversion of a Jew uncommonly difficult; and the pictorial representations of the Trinity, that appeared in the latter part of the middle age, must have seemed like a confirmation of the charges of tritheism which they brought against the Christians. In many places, indeed, the Jews were compelled to hear discourses aiming at their conversion by the monks, but an effect opposite to what was intended was unavoidably produced. It is told of the preacher-monk Vincenz Ferrer, that his eloquence effected 30,000 conversions in Spain. But these ostensible conversions took place in the midst of the horrors of the slaughter of 1391 and of the ensuing occurrences, and the apostasy that soon commenced of 17,000 new converts indicates how much the conversions were worth.

If a Jew voluntarily became a Christian, he lost everything that union with a people holding so firmly and faithfully together had hitherto secured him, and by no means did he win the favor of the Christians; rather did his condition in most cases become worse. For the Church met him with suspicion. In Rome, indeed, it was regarded as a rule, to which there was hardly any exception, that a baptized Jew would relapse. If he had means, it was made a duty for him to return all the interest he had taken, a sum often in excess of his present possessions; and in France it was even the custom to confiscate all his goods, and indemnify the king or baron for his loss of a bondsman, and of the income derived from him. Two laws of Charles VII destroyed this custom; but this very monarch took from the Jews, who avoided exile by embracing Christianity, two thirds of their property for himself; and his contemporaries thought this a softening of the severity of the old statutes. If the converted Jew was poor, he experienced the lack of the means of subsistence; for he had not learned

a trade, nor could he any more take up with traffic in money, and his only resource was to become a barterer and dealer in small wares. The worst and most horrible thing was that the new convert fell a prey to the power of the Court of Inquisition, and, wherever there was an inquisitor, he was liable to arrest and torture on a mere suspicion, and could be sentenced either to money-fines or to imprisonment. That the inquisitor could impose fines upon merely suspected persons was already, in 1330, the teaching of the canonical writers, and nothing was easier or more tempting than the discovery of some cause of suspicion against a rich Israelite, baptized or unbaptized.

While the Spaniards were striving to root out Israel from the Peninsula, they prepared for themselves a most fearful scourge, under whose lashes they were to bleed for centuries. For, since they drove so many Jews into the Church through fear of death, and forced them to continuous hypocrisy, they caused the establishment of the Holy Office, which was directed at first against this secret retention of the Jewish faith. The majority of educated Spaniards at the present day doubtless acknowledge the Inquisition to have been the sorest national misfortune; it was an institution which has served to dishonor the Spanish name, and has been a source of manifold misery and a school of hypocrisy to the Spanish people. But that this institution maintained itself so long in Spain, and for over two hundred years found continually new victims for its "acts of faith," is owing to the events of 1328, 1391, and 1492, along with the distinction, contrived by the Church, between absolute and relative coercion in baptism.

Many thousands of Jews were then forced to be baptized; they were often allowed no other alternative than that of death or entrance into the Church. In many cases they preferred death, and perished either by their own hands or at the hands of their oppressors, and the example of some who were steadfast inspired whole hosts to copy after them. At the same time, there was a considerable number who, in fear of death, or to escape banishment and loss of property, suffered themselves to be baptized; and it was just as natural that, when they breathed free again, they should renounce Christianity and turn back to the cult of their fathers.

The doctrine was indeed continuously taught and accepted that a baptism forced upon one was null and invalid, and it would hence seem self-evident that he who had been coerced should be free to turn back to his ancestral religion. But, as early as 633, the Spanish Visigothic bishops had declared that those forcibly baptized should be held in the Church. This had passed over into Gratian's book of doctrines and statutes, and now no one was any longer permitted to surrender the Christian faith once confessed, or return to the practices of Judaism. He was once for all a Christian, and, as such, subject to the jurisdiction of the religious court; if he went back to the faith of his fathers he must suffer, as every heretic and apostate, the death

by fire. The princes were also ready, in case no Court of Inquisition was in existence, to execute this punishment. The Emperor Frederick III caused a young man, who was valuable to him as a servant, and who, after being baptized out of fear turned back to Judaism, to be conducted to the stake, to which he went singing psalms. In Spain and Portugal the observing of some Jewish rite, on the part of a new convert, sufficed to subject him to imprisonment and torture. It was not realized that by this means the Church was being filled with hypocrites, and that numberless profanations, otherwise sought to be avoided in every possible way, unavoidably took place. In her better days the Church regarded an entrance of her walls, accomplished by the influence of slaughter and terror, a disgrace and a sacrilege; but now all, bishops, priests, and laity, worked harmoniously together to imprint this stigma on their Church—above all, in Spain.

A more painful existence than that of a Jew in the middle ages is scarcely thinkable, and, if he had had a knowledge of history, with what longing would he have looked back to the happy time of the Roman Empire! Every day the Jew must be prepared for some act of extortion, or the loss of all his goods, or imprisonment or banishment. Emigration was often impossible, and was in most cases not permitted, so long as the Jew had any remaining possessions which could be taken from him; and when he did undertake it his condition hardly ever improved; it was often "falling out of the frying-pan into the fire." Moreover, he had to pay a high price for permission to live elsewhere, even if it was only for a few years. On the highways of the country his person was as insecure as that of an outlaw.

The whole external history of the Jews for almost a thousand years makes up a succession of elaborate oppressions, of degrading and demoralizing afflictions, of violence and persecution, of wholesale slaughters, with interchanges of banishments and recallings. It is as if the European nations had vied with each other in trying to create the double delusion that the Jews were condemned till the end of time in the decrees of Heaven to the severest helotism, and that the sons of the Gentiles were ordained to act the part of jailers and hangmen to the chosen people of God! Christians knew not how to dispense with them; they were serviceable in many ways; and yet they could not be endured. Their countenances worked like a challenge upon the believer, who was touched by no scruple, and thought it possible to explain the Jews' fixed attachment to their ancestral faith, under the clear light of the gospel, only as a species of wicked obstinacy.

Nevertheless, one feature is striking in the great mass of abusive discourses, arraignments, and declamatory outbursts against the detested people—a feature which, along with endless repetition of the customary phrases, characterizes the ecclesiastical literature of those centuries: and this is, that their moral life, so far as the family, chastity, temperance, and fidelity to obligations go, is never attacked. Along

with the charge of avarice and usurious money-lending, it is always simply their religious belief that made the ground for charges against them: they are continually accused of crime; and the fact that they did not recognize the Christian doctrines of the Trinity and Incarnation was sufficient proof of their guilt. That they actually railed at Christ and his mother before the ears of Christians was certainly very rare, since they knew that a word of that sort sufficed to devote them, and often also their families, to death. It could not occur to an Israelite to wish to convert a Christian to his own faith. It is written in the Talmud, "Proselytes are as dangerous for Judaism as ulcers on a sound body." If one not a Jew had really a mind to become a convert to Judaism, he must be told, "Do you not know that the Jews live in sufferings and woes, that they are insulted and cast out, tormented and put to the rack?" At the same time, he was reminded of the oppressiveness of the statutes, and of the privations and sacrifices to which he would have to submit.

"The Christian brought the Jews to this pass," Shakespeare makes his "Merchant of Venice" say, and history for thirteen hundred years says the same. When the Jews in Spain were threatened with destruction and banishment, a rabbi is reported to have said to the Christian: "We are at once a people blessed and laden with a curse. Now you wish to destroy us, but you will not succeed, because we are blessed. The time will come when you will exert yourselves to raise us up, but in this you will not be successful, for we are cursed." If this was actually uttered, it is not clear whether the reference was to the Spanish Jews, the Ṣephardim, or the curse was conjectured to rest on the whole people. A retrospect of nine centuries of ignominious treatment and misery might easily have awakened such a thought. But since the Reformation the lot of the Jews has been steadily growing more favorable, and to-day no rabbi can any longer have the sense of a curse resting upon his race. The number of Jews now living on the surface of the globe has been estimated to be very nearly twelve million; should the number be less, it is none the less certain that they are more powerful than they ever were in past time, not excepting the period of their political independence. The official (Christian) interpretation of the word of the prophets, current in the middle ages, is thereby proved delusive; according to it, the Jewish people were to be reduced by continuous mistreatment and persecution to a very small handful of survivors. But in spite of all the heavy blows dealt upon this anvil, and of the numerous proselytes to Christianity and Mohammedanism, they have not lost but rather steadily increased in numbers. For a hundred years Israel has struggled for political emancipation, and at last has won it in all European states; only Russia, Spain, and Portugal have not as yet granted it. It has also not been granted them in the Mohammedan world. But in Europe the larger half of the Jews find themselves in possession of all social and political rights.

Israelites sit now in the parliaments and congresses. They are allowed to be teachers in most of the universities, and the number of Jewish young men who devote themselves to study increases with every year. Important offices are already intrusted to Jews. Their protective union, the judiciously managed "Israelitish Alliance," which has its seat in Paris, appears to be constantly winning greater influence. The facts of comparative statistical science are favorable to them. In most countries, theirs is, relatively speaking, the smallest number of judicial crimes, and they stand foremost among the population in general prosperity and wealth, even in length of life and rate of increase. The old virtues of temperance and continence, of well-ordered and affectionate family life, of filial piety to parents, which served so well in preserving this people from destruction in the troublous times of the middle ages, have not yet vanished from among them. Marriage unions with Christians and conversion are more common than formerly; in Berlin alone several years ago, there were estimated to be some two thousand proselytes.

It is true, however, that there are dark shadows to the picture; the better spokesmen of this people do not deny their serious faults; they must allow that there is abundant occasion for sharply reproving them: they only urge that the faults arrest attention more than the virtues. The strongest charge and the principal reason for the popular hatred of them is the economical injury they inflict, and the manner in which they take advantage of the peasantry in the Slavic and also in some German countries, in connection with small bartering and money-lending, which seem to be their favorite occupations. In the East, particularly in Galicia, this injury is called even by a stronger word —it is named devastation. The fault is undeniable; our Israelitish fellow-citizens lament it as much as we, but it would be unjust to make, on account of race connection, the whole responsible for the conduct of a fractional part, who are far removed and beyond control. The same is true of the founding of sham companies (Gründerunwesen) and the pernicious speculation in money, which is a fault common to Christians and Israelites. As it was formerly alchemists, astrologers, and searchers after hidden treasures, who took advantage of the blind and eager credulity of the higher classes, so now Jewish speculators do the same. In a similar way, the sins of the press of the day are to be charged upon its circle of Christian readers as well as upon the Jewish editors, who only follow the fashion in pandering to, rather than trying to mold, the opinions and passions of the people.

The great reform movement, that began with Mendelssohn in the bosom of Judaism, has given it a new form in Germany, France, and England. Those of the Jewish people who live in Slavic countries remain for the most part untouched by this movement, and are still bound to the Talmudic standards; but in Western Europe the Israel-

ites have given up many of their traditional prejudices and customs, and come nearer the Christians in manners and ways of thinking.

At the present time, Germany is the bearer and foster-father of the spiritual life of Judaism, as in earlier times (and in the order stated) were Spain, Southern and Northern France, and then Holland. The German Israelites lead those of the rest of the world, because of the language they use; they alone, too, have a religious and theological literature of their own, to which their brethren in other countries resort for instruction in spiritual things. And hence it may be justly asserted that the influence of German ways of thinking is stronger than any other one thing among the Jews to-day, and it extends even to North America.

Among civilized peoples with a distinctive moral and intellectual life, the Jew residing in their midst thinks with the bulk of the nation. The German Jew thinks about all questions of spiritual and social life in an essentially German manner, which was far from being the case in the preceding century; and since our culture and civilization have come out of Christianity and have a Christian coloring, the Jew, however disinclined he may be to Christian views, can not help thinking and acting about many things, whether consciously or unconsciously, in a Christian way. So, for example, in regard to marriage, which is regarded by the Jews no longer from the Old Testament point of view, but from the Christian. And the same may be said of the British and French Israelites; they think and feel as the great nation thinks and feels in whose midst they live.

Altogether too long has the false and detestable view ruled in the world that we are called upon to avenge, generation after generation, the sins and mistakes of the fathers upon their guiltless descendants. It is a view which has covered Europe with a multitude of cruel and shameful deeds, the thought of which causes us to shudder and avert our faces. Woe to us and our posterity if such a law of revenge is ever applied to the descendants of the Germans, Frenchmen, Spaniards, and Englishmen of the middle ages! But there is one thing which the self-styled anti-Semitic agitation of to-day should not forget, viz., that hate and contempt are feelings bitter and of no comfort to him who cherishes them, and painful and exasperating to those against whom they are directed. A sad thing it is when (to use a Scriptural expression),

"Deep calleth unto deep."

Rather let the saying of Sophocles's "Antigone" be and remain our motto:

"My nature leads to sharing love, not hate"

PORCELAIN AND THE ART OF ITS PRODUCTION.

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THE uses of porcelain have so multiplied, the employment of that material has become so general, that few persons recollect the time, not yet far back, when it was considered an object of luxury, and only delf was within the reach of all. In this paper I shall consider, first, the nature of porcelain and the history of its discovery; next, the principal points in its manufacture; and, lastly, the different methods of decorating it.

It is generally understood that porcelain is, as a rule, the resultant of the action of fire on a certain kind of clay. No one is likely to confound it with earthenware or delf. While those wares are soft, opaque, and of impure colors, porcelain is always white, is perfectly clear, and is harder than steel. The fundamental distinction between the three wares is that earthenware is obtained by the simple action of fire on common clays; delfs are earthenwares more or less colored and glazed with a leaden enamel, which is rendered opaque by tin; while hard porcelain is obtained from a white clay, kaolin, and is enameled with feldspar.

Kaolin, a natural hydrated silicate of alumina, is absolutely refractory and opaque; it constitutes the resistant part of porcelain. Feldspars are silicates of alumina and potassa, fusible at a very high temperature into a beautiful transparent glass. If, now, we mix a quantity of feldspar with kaolin, cover the mixture with a layer of feldspar, and heat the whole at a very high temperature, the feldspar will melt and communicate to the opaque clay a clearness greater or less according to the quantity of it present, and to the superficial part of it that beautiful glaze with which all are familiar. A part of the action in this process is chemical, and consists in the production of a new crystalline silicate formed by a combination of all the substances present. The discovery of porcelain in China is traced back to a high antiquity. The Chinese have certainly made it regularly for at least a thousand years; many authors fix the discovery at fifteen hundred or eighteen hundred years ago, but no evidence exists to justify our going further back than a thousand years. The first pieces that came to Europe were probably brought by the Venetians at the end of the thirteenth century. Charles VII, King of France, received a present of Chinese porcelains, about the middle of the fifteenth century, from the Sultan of Babylon; but it was not till the sixteenth century that the importation of these Oriental products by Portuguese and Dutch merchants assumed a real importance. The discovery of tender porcelain was made in France toward the end of the seventeenth century, but

whether by Louis Poterat or by Reverend, at Paris or Rouen, is disputed. This ware has no relation with real porcelain ; it contains neither kaolin nor feldspar, but is an artificial product, a kind of glass made from a mixture composed essentially of sand, lime, potash, soda, and a small quantity of marine marl. This mixture, made plastic by the addition of manganese or other fluxes, is baked without glazing, and is covered after baking with a glazing composed of silica, lead, potash, and soda. The beauty of the material, its perfect glaze, and the facility with which vitrifiable colors are fixed in it, make of tender porcelain a ware exceptionally adapted to decoration.

The discovery of tender porcelain did not arrest the investigations of men of science and potters, who saw very well that it had none of the characters of the porcelain of China. A bed of kaolin was found in Saxony in 1709, and Böttger set up at Meissen the first European factory of hard porcelain. Fifty years later, in 1758, Guettard at Alençon, and afterward, in 1769, Madame Darnet at Saint-Yeux, near Limoges, discovered the French beds, and the industrial fabrication of hard porcelain was begun in France in 1774. Tender porcelain gave way quickly in the rivalry with hard porcelain. This was unfortunate, in an artistic point of view, for the latter material is very unaccommodating to the decorator. A more important object was, however, to create for domestic economy an absolutely healthful industry, and much is due to the illustrious Brongniart for having by his investigations put the manufacture of kaolinic porcelain on a firm scientific foundation.

Natural kaolin is never a pure clay, but contains also sand, undecomposed feldspar, etc., in variable quantities, and must first be purified. For this purpose the mass is pounded, and the products are separated one after another by successive levigations with water. The clay, which is extremely slow in settling, is drawn off first, and may be obtained almost pure ; the other deposits, composed of more or less feldspathic sands, are brayed in mills, and are destined to enter in their turn into the preparation of the pastes. The nature of porcelain, its physical and chemical properties, vary infinitely according to the proportion of its two consituent elements (kaolin and feldspar), and as other substances, lime, silicious sands, potsherds, etc., are added, as is often done. Every country and every factory has its composition, which is adapted to the use to which the porcelain is destined, to the degree of resistance that is to be demanded of it, and to the kind of decoration it is to receive. Generally, porcelain is more solid as the proportion of clay increases, and requires a higher temperature in baking ; if, on the other hand, the proportion of feldspar is increased, it becomes more fusible, may be baked at a lower temperature, and submits more readily to decoration, but its plasticity and the possibility of working it easily diminish rapidly. The mixture of the materials should be perfect ; when this is the case, the mass will keep for a long time, and become

more plastic as it grows older. The qualities required of a good paste may be communicated by diluting it and stirring it with water and decanting, or by prolonged beating and manipulation. By treading it out or beating it we not only give it complete plasticity and homogeneity, but we also clear it of air-bubbles which would otherwise swell out in baking and cause much damage.

The next thing is to give our ware the form which has been determined for it in a design previously made. This requires a knowledge of the whole process of fabrication. It would be a mistake to suppose that porcelain can be baked in any desired form. It becomes soft in baking, and has to be supported; and, as it is to be covered with a glass that melts at the same moment, places which need not be enameled must be found for fixing the supports in every piece, unless we are willing to risk having it spoiled. We may thus comprehend one of the difficulties in the manufacture of porcelain, and one of the points in which it differs most from delf.

Articles of porcelain may be shaped without molds or with them. By the former method all the shapes are obtained that may be produced by turning. The clay is first shaped on the wheel by the hand into a rough block of the general shape which the object is destined to assume, and is then left to dry, slowly and with care, to keep it from cracking. When it has been dried to a suitable degree of consistency, it is put upon the wheel again and carefully worked into the exact shape desired, with the moldings and ornaments called for by the design, and by the aid of the most simple instruments.

Articles whose shape does not adapt them to manipulation on a revolving wheel, such as objects of statuary and many lighter objects, may be shaped by molding them. The mold is made of plaster of Paris; to it, when dry, is applied a layer of the porcelain paste, which is pressed into it carefully and as evenly as possible; the earth espouses all the details of the sculpture, and, after a few moments, the plaster having absorbed the water from the paste in contact with it, a shrinkage takes place, thanks to which the proof detaches itself almost spontaneously. The operation is sure to be successful in the case of simple forms whose outlines offer no impediment to taking them from the molds. If, however, we purpose to obtain objects in relief, statuettes, groups of figures, or sumptuous vases, the sculptural decorations of which constitute their chief ornament, the process becomes more complicated. In this case the molder has to divide his pattern into a number of parts, the superficies of which must be determined by the possibilities of taking off the molds; then he must make as many molds in plaster as he has parts of his model; these molds will in their turn serve for the reproduction of each of the parts, which have afterward to be joined and cemented by the aid of the paste diluted in water. After this the seams at the junction of the parts must be rubbed away, and the whole work finished up by a restorer who must

necessarily be an artist. I can not leave this part of my subject without mentioning the property which porcelain has of shrinking when baked. The shrinkage amounts to about ten or fifteen per cent.

A third method of shaping porcelains is by casting, which was discovered at Tournay, 1784, and in which Brongniart has made numerous improvements. Nothing is more simple than the manufacture of a small object by this process. Thus, if we take a plaster mold of a cup, and pour into it a quantity of barbotine, or porcelain-clay mixed with water, the mold will absorb the water from the clay in contact with it, forming a shell less liquid than the rest of the barbotine, and which sticks to the plaster. When this shell has attained a suitable thickness, the rest of the barbotine may be poured out: what remains in the mold constitutes the cup. We leave it to dry, and in a little while it will have gained consistency enough to be taken out of the mold without being deformed. Ware thus made is extremely delicate; the slightest pressure with the fingers may destroy it. This process is used at Sèvres for large pieces, but special manipulations are required for such work; for the weight of the shell which should adhere to the mold when the liquid is poured out, and which should be thicker and heavier in proportion to the greater size of the vessel, is very apt to cause it to separate from the plaster and fall. The least awkwardness might destroy the piece, and this should be avoided at any cost. MM. Milet and Delacour have devised a method, which has been used at Sèvres since 1857, for avoiding such accidents by turning compressed air against the interior of the mold at the moment the barbotine is poured out, to take the place of the liquid and hold the porcelain shell against the plaster. M. Regnault has simplified this operation by exhausting the air on the outside of the mold, which effects the same purpose and is more convenient of execution. The absence of seams, the purity of the outlines, and the clearness of the surfaces obtained by this process, make it one of inestimable value when we wish to get an object of art, and lift it far above the process of molding. The details of the operation are very exacting, but none of them should be neglected. Their importance may be realized by reflecting that a hidden fault in the interior of a large piece, a bubble of inclosed air, a lack of homogeneity in the paste, or other flaw, is not perceptible till after the baking, when the vessel has been decorated, and may perhaps have become of very great value. The slightest defect in the casting may destroy this value.

The objects, having been properly shaped and fitted, have next to be transformed into porcelain by the action of fire, the function of which is to combine the different elements of the paste and determine the fusion of the glazing. The baking is done twice. In the first operation, when the temperature is relatively only moderately high (1,800° to 2,160°), the earth is converted into what is called biscuit-baked porcelain; it becomes very tough and sonorous, and extremely

flexible; in this condition it is submitted to the enameling process. That operation is of the simplest character, and consists in a quick immersion in water holding in suspension a feldspathic rock, which has previously been reduced to an impalpable powder. Yet it requires great care, for the thickness of the enamel must be adapted to the piece; it may be neither too great nor too little, under penalty of accidents; it must be as even as possible, with neither bulges nor thin places. These qualities can not be obtained by dipping alone, so the object has to be retouched with a brush. The next step is baking in the sharp-fire, where the temperature of from 2,880° to 3,240°, at which feldspar fuses, must be reached. A few facts will enable us to comprehend the steps and the difficulties of this operation. Porcelain-clay can not be baked in direct contact with the flames, ashes, and smoke, without being greatly altered. It must, then, for the biscuit-baking as well as for the sharp-fire, be inclosed in protecting envelopes called *gazettes*, or *casettes*—cases of as refractory clay as can be got, in which the pieces are adjusted with great care on suitably arranged supports. It must be remembered that porcelain is baked at the temperature at which it becomes soft; the softening must then be anticipated at the time of fitting the vessel in the *casette*, and all the parts of the object must be supported so as to prevent any possible deformation. At the same time the supports must be prevented from sticking to the piece; and it is only by the aid of many kinds of artifices that the object can be effected without the supports leaving visible marks of their having been applied.

The furnace is divided into two stories, the upper one of which is the dome, or biscuit-baking compartment, and is warmed by the surplus heat that escapes from the lower story and passes through the vent-holes in its roof. The lower story, where the baking with the sharp-fire is done, is called the laboratory, and is heated by a number of fires placed along the circumference of the furnace, called *alandiers*. The *casettes* filled with articles to be baked are arranged vertically and as symmetrically as possible, and properly supported in the interior of the laboratory; when the furnace is filled, the entrance is closed by a double door of refractory materials, and the fires are kindled at the different *alandiers*. The temperature should be raised very slowly and very regularly, in order to avoid unequal dilatations, which would develop breaks in the objects. The heating is watched through little openings left in the walls of the furnace for that purpose, through which the color of the fire is observed. It may be seen to pass in succession from a dark red to orange, bright orange, and white. At the white heat, which is reached in from twenty-four to sixty hours, according to the kind of furnace and fire, the porcelain is near its baking-point. Since no apparatus has yet been invented for ascertaining the precise temperature within the furnace, the condition of affairs inside has to be determined experimentally by means of trial-pieces, which are

put in for that purpose. These pieces become glassy a few hours before the baking is completed, but are apt in that condition to fly to pieces. If the baking is arrested at that point, the pieces would all be excessively brittle, and the batch would be spoiled; so the heat is kept up till the trial-pieces come out glazed and clear, without being brittle; but, if the cooking is prolonged much beyond that point, it will be at the risk of changing the character of the porcelain, and of other serious accidents. It is a very delicate matter to determine the right point for stopping the heat without running upon one danger in the effort to avoid the other. When the cooking has been judged complete, the fire is covered up, the vents are stopped, and the furnace is left to cool of itself—a process requiring from four to eight days.

An equally important consideration with that of the temperature is that of the nature of the gases existing within the furnace. If only white porcelain is baked, it is generally best to have an atmosphere of reducing properties, because the small quantities of iron, titanium, etc., included in the clays, will then be least oxidized, and will not color the mass as would be done with an oxidizing flame; if, however, the porcelain is decorated, it is generally an advantage to have an oxidizing atmosphere; and, as both kinds are generally baked at once, it is only by the best management—by, for example, artificially introducing into the piles gaseous substances adapted to one or the other object—that a satisfactory result can be reached. The nature of the fuel employed is variable. Different kinds of wood and coal are used. Efforts are made to adopt gaseous fuels, with which alone we can expect to be able to obtain a complete mastery over the baking.

Having reviewed as succinctly as possible the principal points in the fabrication of porcelain, we now come to the description of the processes employed to enrich that beautiful material. The art of fixing colors on pottery differs essentially from that of fixing them on cloths, wood, and paper; besides, special qualities, distinguishing it from all other kinds, are exacted of ceramic decoration. A perfect adherence, an absolute resistance to atmospheric agents, a glaze that shall permit the colors to be confounded with that of the object itself, are the characteristic qualities of a handsome ceramic decoration. Since the glazing of porcelain is a rock, one of the hardest substances of the mineral kingdom, it is easily understood that absolutely special processes must be adopted to make a color adhere. The result can be reached only through the intervention of an elevated temperature; and this fact eliminates at once from the palette of the ceramist all organic coloring matters and all minerals of slight stability. We must have recourse to oxides, metallic silicates, and metals. The fixation of these colors is always the result of a chemical action, of a combination that takes place at a high temperature, between the body or the glazing of the porcelain and the materials employed to decorate it. Several different methods are applied for this purpose, but they may be

divided into two classes: decoration by the sharp-fire, and decoration by the enameling furnace. The former method consists in the application upon the porcelain of coloring substances which are fixed and developed upon it at the same temperature as that at which the porcelain is baked. It is the method that gives the most highly prized results, for with it the color is covered by the enamel, and takes a high luster and deep setting, becoming, as it were, of one body with the object. The magnificent blue of Sèvres, certain browns, the blacks, and a few other shades are obtained by this process.

The color may be mixed in the paste, or put on the fashioned object, before enameling, or mixed with the glazing; or it can be put upon porcelain that has been baked and will then be baked a second time in the sharp-fire. This is the process we employ at Sèvres for our blues.

One of the most brilliant varieties of decoration by the sharp-fire consists in what is called the process of applied pastes, or in painting with barbotine upon the raw or biscuit-baked porcelain; by successive, rightly tempered applications we can lay on a considerable thickness of material, on which the artist can with the chisel give a fine finish and thus add great value to his decoration. When the barbotine is applied upon a tinted bottom, charming effects, making the porcelain look like real cameos, can be obtained in the clear material. If coloring oxides are added to the barbotine, a real picture can be obtained. Unfortunately, the number of colors that can be used in the sharp-fire is, on account of the excessive temperature, very limited.

In decoration in the enameling-furnace, the painting is always done on baked porcelain, consequently on enamel, and the heating takes place at a relatively low temperature. Since the glazing is not to be melted, as in the sharp-fire, an intermediate agent or flux is required to make the colors adhere. This is generally a silicate or a silico-borate of lead, or for metals a sub-nitrate of bismuth. When the temperature is raised, these substances melt, attack the glaze, and combine with it, determining by their reaction the adherence of the color. The temperature in these operations is determined by the nature of the fluxes and of the colors; and, as some colors are more sensitive than others, it is frequently necessary to bake in two successive and different fires.

The palette of Sèvres is complete, and is competent to reproduce with a marvelous excellence the chief works of the greatest painters. Notwithstanding the beauty of the sharp-fire colors, and the richness of the palette, much is still left to be desired in the decoration of French hard porcelain. The sharp-fire colors are too limited in number and too delicate to admit of any great variety of effects being drawn from them; and the colors of the enameling furnace, in spite of their richness, have a capital fault. They are opaque, and they cover the porcelain and hide all of its highly prized qualities.

Improved processes of decoration have been devised by M. Salvetat and M. Ebelmen, of which the manufactory of Sèvres has possession, and which, I believe, will permit the substitution for painting of a lively and brilliant decoration, as distinct as that of delf, but which will be as superior to that as the material to which it is applied is more precious and delicate. Using these processes, the artists of Sèvres will be able to go beyond making commonplace copies of what has been made in the East, and to create a genuine French school of porcelain, restoring that material to the high rank which the artistic delfs have nearly taken away from it.

I consider that the manufactory at Sèvres, being a national establishment, supported by the country, ought to lay aside the character of a factory, and become a school of ceramics, devoting itself to the search for new processes, for original forms and decorations, to the creation of workmen and artists who shall be masters in their business; and that it is its absolute duty to give to French industry the results of its investigations. Thus might it become a most useful element in the national industries, and a glory to France and the republic.

THE PHYSIOLOGY OF EXERCISE.*

By EMILE DU BOIS-REYMOND.

I.

ALTHOUGH the reputation of the Romans as a civilized people has somewhat sunken of late, their army-life still awakens unbounded admiration. The Greeks called their army after the camp, the Macedonians after its formation. To the neo-Latins the army is armed power; the Germans seem to regard it as a union of the warriors into a common host. The Romans, on the other hand, as Gibbon has remarked, named their army from exercise. The Greeks aimed at the harmonious development of individuals, without any well-defined purpose. Incessant methodical drill of the manhood, a field of Mars, is essentially a Roman institution, for war was the natural condition of the Roman commonwealth.

Overthrown by the barbarian hosts, the regular army disappeared from the world's stage for a thousand years, and the greatest question of controversy for mankind, whether Christian or of Islam, was how once upon a time the quarrel of a clan over a pretty woman was decided by single combat of knights before Ilium. With the revival of ancient culture on the threshold of the new time, the drilling of troops came again into its right. No one now doubts that, other things being

* An address at the anniversary of the Institute for Military Surgeons, Berlin, August 2, 1881.

equal, the better-schooled army prevails. Hardly any army deserves better than the Prussian-German the name *Exercitus*. Before a meeting of the physicians of that army it is not inappropriate to consider exercise somewhat in its direct physiological aspect.

Boyish excesses have brought the Darwinian doctrine into such bad repute in wide circles that I do not without consideration place myself at its point of view. Yet, whatever view of the world one may take, science, which desires to comprehend the world, will not be prevented from at once representing the world comprehensively; since it, according to Herr Helmholtz's evident remark, must start out from this presupposition unless it is contradicted at the outset. Only mechanical conception is science; when supernaturalism comes in, science ceases. As the jurist takes the law, without considering equity and palliating circumstances, so the naturalist goes on to mechanical conclusions, without regarding venerable beliefs. It is not his office to reconcile these beliefs with those conclusions.

More, the Cuvierian doctrine of repeated creations underlaid by repeated cataclysms has lost all justification since Lyell showed that geological phenomena have proceeded without general cataclysms, and Darwin has added that species change. Now we can more intelligibly ascribe to the creating Almighty only the action of having placed a first germ of life in previously inanimate nature. Is it not, then, simpler and more worthy of that Almighty to conceive that he at once endowed matter with the power of allowing the living to arise out of itself under definite conditions, without new assistance?

This was Leibnitz's view, and it may be said of it that even the most cautious need not be afraid of it. According to this view, it is the object of natural research to show how the living originated by mechanical processes out of the inorganic, and how, out of this doubtless most simple life, the present organic nature has been mechanically developed. If we could succeed in filling up the scheme of the theory of descent with real contents, we should know how the series of living beings has unfolded itself during unlimited time and through numerous generations, according to certain norms which appear to us as laws of organization. But with this the problem would be only half solved.

Living beings are in themselves fitted to their purpose, and adapted to the external conditions of their lives; they were always so; and, while they transform themselves according to their surroundings, they not merely adapt themselves to their new conditions, but they also perfect themselves in our human conception. Thus, from this point of view, organic nature appears not only as a machine, but also as a self-improving machine.

This second half of the problem demands for its solution the proof that the adaptive process has gone on mechanically, and the only not wholly vague effort to give this proof that has yet been made is the

theory of selection. Unfortunately, however, this theory encounters insuperable difficulties as soon as it tries to step from the free-sailing air-balloon of probabilities upon the hard ground of realities. Nothing is easier than to ridicule the doctrine of natural and sexual selection. So much the more earnestly will the seeker for truth seize any means that can contribute anything to the solution of the problem. Is it not now a most promising coincidence that the higher beings exhibit in exercise such a self-improving machinery as we have recognized in the aggregate of life?

From these remote distances of research, which are the peculiar metaphysics of our time, come with me into a blacksmith's shop. The lad who lifts the hammer for the first time to-day soon becomes tired in spite of his splendid muscular foundation. He sweats; and, when he takes a horseshoe from the master's hands, he burns his fingers. Two years later he can, without sweating, perform the trick illustrating the mechanical theory of heat of pounding cold iron red-hot, and is not afraid to touch the hot metal. What has happened? First, the lad's arms have increased in compass, their muscles in tension to the highest capacity of contraction. If we could have weighed the muscles of his arms at the beginning of his apprenticeship, and could weigh them now, we should find that they had grown heavier; as also, according to Edward Weber, the muscles of the right side of the body are heavier than those of the left. The muscles are also the most perfect power-machines—not only in that when active they make the most complete use of the consumed matter; not only in that, according to Herr Heidenhain, their strength in particular instances increases with the service demanded of them—but they are distinguished above all machines made by man in that by frequent labor-service they become stronger and more capable of enduring further labor. It does not need to be proved that the effect of exercise on the muscles is immediate and local, and not transmitted through the favorable influence of bodily exertion on the general organism. Even the Greeks found fault with the disproportionate degree to which boxers trained their arms only, and runners their legs; and our pugilists and ballet-dancers are illustrations of the same. Under some circumstances the local results of exercise may be destructive to the whole, as when the muscles of the heart suffer hypertrophy in consequence of excessive resistance in some part of the circulation.

On the other hand, the surgeon knows only too well that the muscles of a stiffened or sprained joint, or of one that has been confined with bandages, become wasted, as do likewise muscles the nerves of which have been cut or that have been otherwise disabled.

The part is known which the latter fact, falsely interpreted by the older physiologists, played in the question of what was called the Hallerian muscular irritability, till John Reid—at a time when experiments on living animals were not prohibited in England—showed

that muscles deprived of their natural innervation could be kept fit for work provided they were electrically excited at sufficiently brief intervals; an experiment which found an important application in surgery and neuropathology.

Even in the midst of health unused muscles pine away, or become pale and powerless, like the ear-muscles of most men. In general, the redness of muscles is related to greater strength in consequence of frequent exertions. Herr Ranvier showed that the red and pale muscles occurred together in rabbits and rooks; that they were distinguished by their structure and by the time required for contraction without its being possible to decide that one set worked more than the other, and without any clew being given to the object of this disposition. Little is known of the microscopic qualities of used and unused muscles. In contrast with the muscles of fattening cattle, working cattle have thicker primitive bundles and coarser sarcolemma, the latter determining the lesser nutritive value of the flesh. According to Herr Virchow's terminology, nutritive stimulation has also taken place. In muscles falling away through disuse, as the waste progresses a fatty metamorphosis sets in, against which, as is well known, its ceaseless activity does not protect the heart-muscle. Muscular contraction is accompanied by chemical changes. The blood flows darker from tense than from resting muscles; they consume more oxygen and form more carbonic acid. An acid permanently reddening litmus is set free in them. Their watery constituents and the amount of substances soluble in alcohol increase in them, while the amount of substances soluble in water diminishes—probably because glycogen is consumed in the contraction. The albuminous constituents remain about the same, yet the derivatives of albumen known as the flesh bases appear to be richer. That to the last hard-working muscle, the heart, is for this reason a mine of such bodies to the chemist; and the flesh of a fox that had been shot was found by Liebig to be ten times richer in creatine than that of a captive fox. We are, unfortunately, still very far from understanding the connection of these various processes and their relation to muscular contraction, that is, to the interchange of isotropic and unisotropic substances in the muscular fibers, and to the transformation of mechanical, thermic, and electric forces. We only know that there is involved an increase and modification of a process of change that was already going on during rest, particularly of the oxidation of nitrogenous substances, by which, in addition to mechanical labor-service, an apparent surplus of heat is developed. Even the muscles at rest are a seat of respiration and the development of heat in animal bodies. The muscle acts very much like the reserve-locomotive that stands ready for use on the switch, which is all the time burning a little fuel and can be attached to a train or sent to help a disabled engine at any instant, but which requires, in connection with the greater display of force it is to make, a greater consumption of material and expenditure

of heat. Ludwig and Sadler showed on this point that, aside from mechanical hindrances, the blood flows freer and richer through the vessels of the working muscle. This is not only in the sense that new combustible matter is introduced, but also in that the ashes are at the same time swept away from the muscle-hearth; since, according to the discovery of Herr Johann Ranke, followed out by Hermann Roeber, the acids formed by muscular activity depreciate the mechanical and electrical capacity of the muscle, exhaust it chemically as we are accustomed to say, without being able to conceive any other than a chemical exhaustion of the muscle. Still less than of the chemical mechanism of muscular contraction, have we a conception of what takes place chemically in the strengthening of the muscle by exercise, of how it becomes better fitted for work through a higher degree of oxidation, and of why it falls away on the cessation of the changes that take place in it in activity. It seems most natural to think that these effects depend alone upon the increase and diminution of the flow of blood during activity and during rest; yet this of itself only makes the case darker than if we had not ventured to decide the question in such a way. Chemistry throws the manifold varieties of muscle-flesh which our taste distinguishes with so much refinement generally into one pot; and the old statement, established in knowledge, that English park-deer tastes flat, is still far from being explained.

A subjective explanation is finally to be mentioned. The tired muscle, as long as it is becoming stronger through exercise, gives pain for several days when it is used and when it is pressed upon. Even a muscle which has been once or oftener hardened, or thoroughly trained, gives pain when it is again put to work after a long idleness, as we soon learn when we begin a journey on foot or on horseback. Whoever, after a long interruption in gymnastic exercises, feels no more pain, will make no further progress. The muscles hurt after epileptic spasms. Even if we attempt to ascribe the feeling of the muscles to the nerves of the tendons, joints, and skin, and the Vater-Pacini bodies, we still should not imagine that they bring on the pains in tetanus and trichinosis. Notwithstanding Sach's labors, we are not yet in the light concerning the pathic nerves that bring about these pains. Wherever and however they do it, they also produce muscular aches after exertions.

The improvement of the muscles by exercise, little as we know of it, has been established from antiquity, and, being relatively more familiar, the best case of improvement, is fitted to serve as an example for similar processes in other tissues. Indeed, the question now is, whether other tissues than the cross-striped muscles are by frequent exercise of their office in the animal household made better fitted for that office. After what has been said above, we can with some justification add to this question the many times more

easily answered one, whether other tissues diminish in consequence of a failure to exercise them in their office.

A physiological proof that the smooth muscles are strengthened by exercise is wanting. The adaptation of the eye to near vision diminishes from childhood to age according to a regular law, notwithstanding the constant exercise of the faculty; but it does not follow from this that Brücke's muscle does not gain strength, for its gain may be more than compensated by the growing stiffness of the tissue and the diminished elasticity of the crystalline lens. The fact that men see imperfectly at close range what their occupation gives them little occasion to regard, indicates that Brücke's muscle loses strength when it is not used. The uterus has no occasion to be exercised, for it is active only after long pauses, and gains a portion of new fibers every time for that purpose. We know nothing of the movements of the muscle-maw of the bird, which forms a transition to the cross-striped muscles. On the other hand, such pathological facts as the hypertrophy of the muscles of the bladder and the pylorus under circumstances of extraordinary resistance leave no doubt that the smooth muscles, like the cross-striped ones, are strengthened by labor. Thus an empirical basis is given to Herr Rosenthal's supposition that the immunity against cold conferred by cold-bathing depends upon the exercise of the smooth muscles of the skin and their vessels, which are intrusted with the lowering of the co-efficient of cooling of the body in the cold. Cold washing and bathing are the gymnastics of the smooth muscles.

The young blacksmith, of whom we spoke a short time ago, had gained another advantage from exercise besides greater strength in the muscles of his arm: he ceased to burn his fingers. Every one knows that the epidermis thickens on those parts of the skin that are frequently subjected to pressure, rubbing, and the touching of hot things and caustic fluids. Handling of tools, rowing, vaulting on the rack and bars, produce a callus chiefly at the ends of the middle-hand bones or in the palms; glass-blowing produces callus on the inside of the fingers. Recurrent blisters often result in callus. Under the pressure of hard shoes the form of skin-thickening known as corns takes the place of callus. Callus and corns have been histologically investigated, yet we can not tell why the useful callus is formed here, the painful corn there, to say nothing of our having a theory of the processes. They fall in the category of what Herr Virchow calls formative stimulation of the cell-complex, and regards, like the nutritive stimulation, as the result of a general and fundamental property of the elementary organisms. An increased supply of matter, immediately conditioned on an increased flow of blood, also takes place here. Since we can not well predicate a *vis a fronte*, enlargement of the vessels remains the only yet possible step toward an understanding, and with this we reach a closed gate before which many other problems are

already encamped, in the question how inflammation and vascular paralysis are distinguished. Our case is also distinguished by the fact that the skin, protected by callus like the practiced muscles, now affords better service under similar circumstances. The callus, in particular cases, represents an improvement in the grasping organ. Formative stimulation also occurs in the muscles; the contents of the primitive bundle are moved to nucleation through local stimulation, yet the advantageous stimulation by exercise seems to be almost entirely, or chiefly, of a nutritive sort.

In like manner as the skin fortifies itself against the repeated touch of hot bodies by means of local calluses, it adapts itself to the heat of the sun through erythema and a change consequent upon it which is accompanied with the development of pigment, although pigment favors the absorption of the sunbeams. The fact is, perhaps, connected with this, that it is advantageous to animals to have the side that is turned toward the light of a dark color. Hence, as Moseley observed on the Challenger, *Echeneis remora* has the belly dark, the back light. Heat from artificial sources of a relatively lower temperature, which is deficient in refrangible rays, has a remarkably different effect from sunlight. Workers by the fire are pale. It is still to be seen whether the electric light will take the place of the sunlight in its effect on the skin as it does in the case of plants.

Horny structure becomes unfit for its purpose with insufficient use. A remarkable example of this is the cessation of the growth of the hoofs of horses and cattle on the soft turfs of the Falkland Islands, mentioned by Darwin. On the other hand, the hoofs of horses harden on dry, stony soils, as Xenophon teaches in his school for horsemen; and colts brought up on such soils need no protection.

The so-called rider's bones, the exercise-bones, which have not become rarer since the introduction of the new armor and the modified drill, but have moved from the left to the right, may be considered as a kind of inner callus, the development of which affords a new exemplification of the Osteo-blasten theory. These bones hardly bring any advantage to their possessor, and can not be included among the instances of self-improvement through exercise. It would be too far fetched and groping in a too dark quarter for me to do more than mention here that Ludwig Fick believes that the well-adapted form of the joints may have been derived from exercises during the fetal period and the earliest days of life. Is it not possible that the splendid formation of the spongy bone-substance in the epiphyses, which was discovered by Hermann Meyer, and further investigated by Julius Wolff, depends on nutritive and formative stimulus in the direction of the greatest pressure and strain? The injurious effect of insufficient use is shown in this region by the non-growth of the teeth of rodents when they are fed on too soft food, or after the trigeminus has been cut.

The self-improvement of the series of connecting tissues by exercise in other members, takes place in a more peculiar manner, rather mechanical than chemical and physiological. The motions of the joints are made easier by exercise; and making stiff joints movable is one of the most grateful objects of orthopedy. Herr Henke explains the unusual suppleness of the so-called India-rubber men as the result of relaxation of the ligaments, a disappearance of edge-surfaces of bone, and a diminished radius of curvature of the sliding surfaces, but particularly of a prolongation of the flesh-fibers at the expense of the tendons. Possibly an elastic tissue is formed in the ligaments of their limbs. Whether such a tissue grows in the vocal cords after exercise in vibrating them is still uncertain.

To make our statement complete, the increased ease in labor—bought, it is true, at the cost of greater danger of secondary bleedings—of those who have borne many times, belongs here. We may also regard as a self-improvement, although belonging to another region, the relaxing after-birth, and the accompanying reflex action of the breast upon the uterus.

The glands are another class of tissues the efficiency of which is raised by exercise. The sexual glands—the milk-glands and testicles—are known to be capable of remaining at rest for years and even for life, while their tissues are subject to a considerable diminution, as is also normally the case with animals during the intervals between the periods of heat. Inversely the sexual glands attain a wonderful degree of production by means of alternations of rest and activity, as is exemplified by stallions, milch-cows, sheep, and goats. If the breast-glands are not kept exercised by sucking, the udder by milking, they dry up and sink to rest till they are newly excited in sympathetic action with the uterus. The same can not be immediately proved of the fluids of secretory glands, but it is hardly doubtful that a digestive vessel that is kept active by two meals a day, with its glandular attachments, will dispose of a larger quantity of the various digestive fluids than that of a penitent. The kidneys of the practiced beer-drinker give passage to an incredible quantity of fluid. Finally, one who reads in the sketches of the manners of the last century of the continual weeping of the sentimental men and women of the time, will hardly be able to restrain the presumption that their tear-glands were brought up to the work by practice. We are as ignorant concerning the mechanism of the self-improvement of the glands through exercise as concerning the process of secretion in them. Since this process is different in nearly every gland, according to what nerves are introduced—in one the secreted matter increases; in another becomes fatty; in another persists unchanged, but receives and gives out matter, or undergoes changes in itself—the problem appears twice as intricate and the information doubly scanty, so that at last we have to do again only with an increased accession of matter and more frequent innervation.

The idea of exercise as we have regarded it passes so gradually over to hardening against frequently repeated injuries, that I am tempted to place here also the adaptation of the organism to accustom itself to endure poisons. Without going back as far as King Mithridates, many men have by habit made themselves comparatively proof against alcohol, nicotine, and the alkaloids of opium. The North-Germans are only too proof against Pettenkofer's man-poison (my anthropotoxine) in badly ventilated assembly-halls, railway-carriages, etc., to which fire-place people, like the English, are so sensitive. This inurement can hardly be called self-improvement.

You have, perhaps, gentlemen, been waiting in impatient expectancy for me to speak on the subject you first thought of when you heard that my address was to be on exercise. By exercise we understand commonly the frequent repetition of a more or less complicated action of the body with the co-operation of the mind, or of an action of the mind alone, for the purpose of being able to perform it better. Not without a purpose have I deferred the consideration of this kind of exercise to this point, for it is quite different from the kinds previously spoken of, although those kinds may be connected with it. This fundamental difference has not as yet been duly considered. We seek in vain in most physiological text-books for instruction respecting exercise; if it is given, only the so-called bodily exercises are generally considered, and they are represented as merely exercises of the muscular system; therefore it is not strange that laymen in medicine, professors of gymnastics, and school-teachers generally believe that. Yet it is easy to show the error of this view, and demonstrate that such bodily exercises as gymnastics, fencing, swimming, riding, dancing, and skating are much more exercises of the central nervous system, of the brain and spinal marrow. It is true that those movements involve a certain degree of muscular power; but we can conceive of a man with muscles like those of the Farnesian Hercules, who would yet be incompetent to stand or walk, to say nothing of his executing more complicated movements. For that we have only to add to our conception the power of arranging the motions suitably, and of causing them to work harmoniously.

Thus it becomes clear, if proof were needed, that every action of our body as a motive apparatus depends not less, but more, upon the proper co-operation of the muscles than upon the force of their contraction. In order to execute a composite motion, like a leap, the muscles must begin to work in the proper order, and the energy of each one of them (in Helmholtz's sense) must increase, halt, and diminish according to a certain law, so that the result shall be the proper position of the limbs, and the proper velocity of the center of gravity in the proper direction. We know little as yet of the way in which we impart a definite duration to the energy of the muscles, for our researches have so far informed us upon little else than the convulsions following extremely

brief excitations, and upon tetanus. Since the nerves only transmit the impulses coming from the motor-ganglion cells, it is evident that the peculiar mechanism of the composite movements resides in the central nerve-system, and that, consequently, exercise in such movements is really nothing else than exercise of the central nerve-system. This possesses the invaluable property that the series of movements (if we may speak thus), which take place in it frequently after a definite law, are readily repeated in the same order, with the same swell and ebb and intricacy, whenever a singly felt impulse of the will demands it. Thus, all the bodily exercises we have mentioned above are not mere muscle-gymnastics, but also, and that pre-eminently, nerve-gymnastics, if for brevity we may apply the term nerves to the whole nervous system. Johann Müller, whose explanations, in the second volume of his "Hand-book of Physiology," still appear to me the best that have been written on the theory of movement, has recognized this double nature of bodily exercises, but has not sufficiently insisted upon it. On this, he makes a remark which strikingly enforces our view; that is, that improvement in exercises of the body often consists nearly as much in the suppression of unessential by-motions as in acquiring dexterity in necessary motions. Observe the active boy who for the first time raises himself upon a ladder with his hands. Although it is of no use to him, his arms and his legs shake at every grasp. After a few weeks he holds the hips, knee and foot joints of his closely locked legs tautly extended. The suppression of by-motions furnishes unconsciously to us a mark of the pleasing appearance of the well-drilled soldier, of the skilled gymnast, and of the cultivated man; chorea begins when they are let loose. We know nothing of the mechanism of the suppression of by-motions, yet it is evident that, when muscles remain at rest in the course of exercise, the result of the exercise is not to strengthen them.

Under continuous severe exertions, as in mountain-climbing and long walks, the heart begins to beat faster and more strongly, and oppression of the breath is felt, because, according to Johann Müller, the heart participates in a by-motion; in Traube's opinion, because it is stimulated by the excess of carbonic acid formed in the laboring muscles. How is it, then, that exercise diminishes these palpitations? Is it by means of the vagus nerve?

Perspiration under exertion may also be regarded as a by-secretion as well as the greater secretion of saliva in speaking and chewing; and the diminished perspiration of our blacksmith when taught would then be the suppression of this by-secretion, which might be compared to a by-movement, through exercise. The beating of the heart and perspiration are, however, involuntary, and it is very questionable whether we can refer the stopping of them by means of exercise to such processes.

Still, something else than the control of the muscles by the motor-

nervous system comes into consideration in most composite movements. The sight, the sense of pressure, and the muscular sense, and finally the mind, must be prepared to take in the position of the body at each instant, so that the muscles may be in a proper state of adjustment; this is plainly shown in the exercises of fencing, playing billiards, rope-dancing, vaulting on horses in motion, or leaping down a mountain-slope. Thus not only the motor, but the sensor nervous system also, and the mental functions, are capable of being exercised and need it; and the muscles again appear to acquire a deeper importance in gymnastics. What is said here of the coarser bodily movements applies equally to all skilled work, of the highest as well as of the lowest kind. Although a Liszt, or a Rubinstein, without an iron muscularity of arm, can not be thought of, and although, likewise, the movements of Joachim's bow during a symphony may correspond to many kilogrammemetres, still their power as virtuosos resides in their central nerve-system. The readiness of the turner, the machinist, the watchmaker; of the glass-blower and glass-polisher; the skill of the anatomist and surgeon; writing and drawing; womanly labors like sewing and knitting, crocheting and lace-making; finally, the hardly considered yet more or less artful performances of daily life, dressing and undressing, the use of the sponge, comb and brush, knife and fork—what are they all at last but acquired concatenations of the actions of ganglion-cells which, after they have often run on in an appointed course, now succeed each other in the same manner with qualified facility, catching into each other, pausing and resuming again, like the voices in an artfully composed concert? When Lessing asked whether Raphael would have been any the less a great painter if he had been born without hands, he perceived this truth. Is it necessary to add that the same principle applies to all the movements as well as to those of the hands; that, for example, vocal culture rests upon no other one? Singers need not only flexible vocal cords, strong respiratory and laryngeal muscles, ringing resonance of the air-passages—all these would in themselves alone be of no more use to them than a Stradivarius violin to a wood-cutter—their talent has its root in the gray substance at the base of the fourth ventricle. Here also is concealed, but awaiting a higher command, exercising its functions through the hinder third of the left third convolution, the machinery of the speech mechanism, as bulbar paralysis sadly teaches.

It is very remarkable in all these processes that the more any composite movement is practiced, the more unconscious is the act of the nervous system directing it, until at last the latter can not be distinguished from spontaneous nervous mechanisms like the involuntary reflex and by-movements. Erasmus Darwin remarked that, when any one learns to turn, each movement of the hands seems at first to be directed by the will, but that at last the action of the hands becomes so at one with the effect that the turner's will seems to reside in the

cutting of his knife—that is, that he unconsciously puts it in the right position.

Practice further exhibits its influence upon the nervous system on its purely sensory side, abstracted from all movement. It sharpens and corrects the musical ear, and teaches it to perceive over-tones, inexact intervals, and slight dissonances. The local sense and the color sense of the eye are improved by practice. It teaches the wonderful arts of quick reading, of taking in fleeting phenomena like the vibrations of the magnetic needle, of bringing the sight of the gun to bear on the black of the target. It teaches to distinguish copies and all kinds of subjective appearances, to comprehend at a glance microscopic pictures that pass before the beginner in superficial confusion, in such a way that it is very hard to draw the line between exercise of the sense and that exercise of the judgment over the impressions of sense that is called *visus eruditus*. As exercise induces the discontinuance of unused muscles, it also teaches us to neglect unused images, such as the double images of the points of the picture outside of the horopter; or, in looking through an optical instrument, the impressions made upon the unengaged eye. Yet no practice appears to break through the law according to which the points of the retina in indirect vision receive attention only transiently and with a certain effect. Although it is hardened against bad smells, the nose of the chemist is the rival of spectrum analysis in delicacy. It would be unjust to say that the wine-connoisseurs of Bordeaux can discriminate concerning the place of the growth of a vintage, while only its age is in question with them. Not less susceptible of cultivation are the perceptions of temperature, pressure, and locality. The last, especially, measured according to the least distance at which two bodies, nearly in contact, still separate, may be distinguished, become sharpened by practice in the course of a few days—giving one of the arguments which oppose a purely anatomical definition of the range of feeling.

As exercise refines the senses, neglect stupefies them, and that not merely in consequence of the apathy of the organ. After destroying the eyes and ears of new-born puppies, Herr Hermann Munk observed that what he had recognized as the visory and auditory spheres of the brain borders were backward in development. According to Huguenin, blindness of many years' duration results in waste of the visory spheres.

A CURIOUS BURMESE TRIBE.

By Lieutenant G. KREITLER,
of count szechenyi's central asian expedition.

IN our journey from Sayang in Yunnan to Bhamo in Burmah, we became acquainted with a race of mountaineers who are called Kacheen by the Burmese, but who call themselves Chingpos. They

are a small, delicate people, whose brightly-beaming eyes contrast strongly with their reserved behavior. The faces of the men as well as of the women can not be called unhandsome. The head is oval and well-shaped, the eyes are horizontal, the nose is strong and straight, the ruddy lips are finely cut, and the teeth are blackened with betel-juice.

All the hard work among the Kacheen is done by the women and girls, who are up in the morning at their household duties while the men are still in bed.

The woman does not venture to raise her eyes when she speaks with her husband or her employer. She has no concern about the business or enterprises that he is engaged in, but considers everything good and unquestionable that he orders ; and the subjection of the women goes to the extent that the death of one is lamented as a pecuniary loss, because the laboring force is diminished by it ; and a family that has several daughters is for that reason considered rich. The women are all the time at work, cutting down trees, splitting wood and bringing it to the house, cutting roads through the thickets, driving the cattle to pasture, cleaning the house, getting the meals, and weaving cloth. The men perform no manual labor, or, at most, will once in a while go out into the field and show the women in a rough way how the tillage ought to be done. Their principal business is to visit their neighbors, to drink *sheru* (a sweet drink made from rice), and smoke opium. Only in case of pressing need will they take their mules and their women and go to Bhamo and get loads of goods to take to China. Marriages among the lower classes are mere business affairs, in which the dowry and physical strength of the bride are the first considerations. Among the higher classes weddings are regarded as important events, and are distinguished by particular usages and ceremonies.

When a death occurs, the relatives make the sad event known to their neighbors by firing guns. When the friends are gathered together, a part of the number go into the woods to prepare the coffin, while the others sacrifice to the household gods. The coffin is hewed out, after sacrificing a hen, at the place where the tree is cut, and the part where the head is to lie is blackened with coal. The corpse is washed, dressed in new clothes and laid in the coffin, with a piece of silver in its mouth to pay its ferriage over the river. The old clothes of the deceased are laid, with a dish of rice, upon the grave, and rice is scattered along the road on the way home. The mourners afterward assemble and celebrate the event with singing, dancing, and drinking, as long as the *sheru* lasts.

Persons who die by the sword are wrapped in a straw mat and buried as soon as possible, and the friends build a hut for the wandering spirit of the slain. A similar custom prevails with regard to those who die of small-pox, and to women who die in childbirth. In the

latter case, the Kacheen believe that the dead are changed into evil spirits, and for that reason young women have an indescribable horror of such a death.

It is evident from these facts that the religion of the Kacheen has nothing in common with Buddhism. Their religion includes the belief in a Supreme Being who has created everything, in a heaven and a hell, and a future state of rewards and punishments; but the views of individuals do not give the slightest clew to a clear definition of their faith. The mountaineers, however, all agree in a *cultus*, which consists in giving honors to the so-called Nats, or tutelary genii. They also believe that the spirits of murdered persons, under the name of Munda, make the mountains unsafe, and that they take possession of those persons over whom a similar fate is pending. The Kacheen have an unwritten language, and a very primitive method of computing time. Their year begins on the day when they begin to eat the newly harvested rice, and ends on the day that a dish of fresh rice is again gathered.

Slavery has existed among them from a considerable antiquity. Boys and girls are stolen in Assam and sold to wealthy Kacheenese. A young slave is worth about twenty dollars, a full-grown man only about ten dollars. The lot of the slaves is not very hard, and their children are regarded as more or less members of the family.

The food of the people consists of rice, beans, pork, and dried fish imported from Burmah. The men eat separately from the women.

Their towns are composed of from three to ten houses, each of which is surrounded by a stone-wall about six feet high. We were always required to dismount before passing the wall, for the mountaineers have religious scruples against allowing persons to ride on horseback into their courts. The houses are light bamboo structures, without iron or stone work. A north-and-south passage leads into the interior, which strangers are allowed to enter only from the south. First we passed a stable, whose fence was adorned with the horned skulls of buffaloes, and the marshy floor of which yielded at every step. A few steps led to the dwelling-house proper, which appeared to be divided into a western and an eastern half. The western part consisted of a series of closed rooms, the eastern half of three apartments open toward the long passage, in the middle and largest of which was built the hearth, where a fire was constantly kept up.

The head of the house and his family live in the inclosed rooms, the domestics and slaves in the opposite rooms. The floors are of plank, and kept clean, and the ceiling is identical with the smoke-blackened roof. The whole house is built on piles. The few other domestic buildings are grouped around the inclosure-walls, and are commonly situated on the edge of the thick and gloomy forest.

The Kacheen call all their chiefs, who rule each over a small territory, Tsobwa. The Tsobwa receives yearly from his subjects as tithes

a large basket of rice and a quarter of the meat whenever a domestic animal is slaughtered; and he exacts a small toll from every caravan that passes through his domain. His office is hereditary, as is also that of his prime minister, who is called Pomein. The chief himself administers justice; but in important cases he calls a council, which meets either around the fire in the house or in the open air. These chiefs seem to be quite independent, and only indirectly under the influence of the Chinese Government. The relations between the Kacheen and the Burmese are of constant hostility, frequently breaking out in murderous outrages. The country of this people is a broad strip of land extending from the Snowy Mountains of the north, between the valleys of the Tapeng and the Irrawaddy, to about the twenty-fourth parallel of latitude.

PROBLEMS OF PROPERTY.

By GEORGE ILES.

THE problems of property form an interesting department of social science. They involve questions as to the growth and distribution of wealth, the province of government with respect thereto, and similar inquiries scarcely susceptible of treatment by formal scientific methods. Still, the subject is one of sufficient importance to warrant a brief sketch of it appearing in the magazine which was the first to give the American public a scientific exposition of the principles of sociology.

The institution of property is, in many quarters of the world, finding active criticism. German and French socialism, Russian nihilism, the Irish Land League, and weighty utterances by the leaders of thought in Europe and America, all declare that the institution of property requires reconsideration and reform. It is very commonplace, indeed, to say that respect for the rights of property insures the chief stimulus to industry, intelligence, and thrift; yet, in the complexity of modern life, the distribution of wealth has become so unequal that discussion of how justice may be feasibly and safely introduced into the laws and customs affecting property is of urgent importance. The natural differences among men in the way of aptitude and ability are always wide enough to cause a variety in human fortunes sufficiently trying to the less capable classes of mankind, were there at work no other cause for disparity in worldly success. When, however, in addition to having to accept the smaller reward in the smaller sphere, the man of but moderate or little ability has to suffer the restrictions which come from the artificial enactments of law and society, discontent easily takes root in his heart and flourishes.

The spur to the accumulation of wealth is undoubtedly sharpened by the power of bequeathing one's possessions to one's family and friends; yet it is this power of bequest, gradually increased through the centuries to its present breadth, which furnishes the most difficult part of the problem of property. Re-enforced in Great Britain by the laws of entail and primogeniture, it has led to the concentration in the hands of a few of a large proportion of the entire wealth of the country. The heirs of unearned lands, houses, and funds are without the healthy natural spur to useful work which universal experience declares necessity to furnish; and subtile moral poison is distributed through society when, as in Great Britain, long trains of bequest bestow the choicest estates and social positions in the realm upon a few individuals through the mere accident of birth. When merit and the means of enjoyment are so often unrelated, as we see them in Great Britain, there is valid ground for complaint and a plain source of envy on the part of the millions apportioned to toil, while some have unearned luxury and ease. Is it right that, because a man, centuries ago, was successful in battle or a favorite of his king, or generations ago was engaged in lucrative trade and thus gathered possessions together, his posterity should be maintained for indefinite time by the working world? And is it right that his descendants should reap richer and richer rewards, as years roll by, from the increase in value conferred upon their estates as the surrounding population grows more numerous and advances in intelligence and industry? Why should books and inventions, which are peculiarly the creations of a man, be so imperfectly protected, and only confer rights terminable in a few years, when rights in ordinary property are so nearly absolute? Such are the questions which are being put to the political economists and legislators of to-day, and their just and peaceful solution will demand a wisdom and forbearance which we may be disappointed in expecting.

The most patent evils with which the institution of property is commonly charged are those connected with land, and here it is that the agitation for property reform has usually begun. The researches of Sir Henry Maine and M. Laveleye show that the primitive cultivation of land was communal. Such still is the Russian *mir* and Swiss *Allmend*. Under communal systems every child born upon the land was guaranteed subsistence, and wide disparity in fortune between individual and individual was scarcely possible, so that pauperism was unknown. How the communal systems gave birth to our existing methods of individual possession M. Laveleye tells in an interesting way in his work on "Primitive Property." The practical fact which concerns us is that, among civilized nations individual property is established and is held to need reform. The change from communal and clan ownership of land to the tenure of recent times has been attended by a gradual divorce of the responsibility which formerly attached to land-owning; if the responsibility now exists at all,

it does so as a moral feeling which may be neglected with no legal penalty and often no social odium. The Duchess of Sutherland could banish the occupants from the estates which their ancestors had tilled for centuries, and convert the land into pastures, yet legal resource there was none. A sybarite Marquis of Hertford could live in Paris for thirty years together, with an income of ninety thousand pounds, and dismiss without a reply a deputation of his Irish tenants petitioning for assistance in building a much-needed railway. Could the original founders of the two families thus unworthily represented have treated their retainers and tenantry thus haughtily and unjustly, and not suffer for it? I think not. The rules of property, devised with a limited glance into future time, and with no expectation of the vast strides in population and wealth which the world has made during the past century, have had very awkward strains put upon them—strains which they were not originally expected or intended to bear. The rise of manufacturing towns and the drift of the rural population to the cities have conferred upon land-owners an immense multiplication of their fortunes, and made the incomes of many of them aggregate sums far beyond the legitimate demand of mortal, and this to the plain deprivation of the public.

Mark, too, the influence of the landlord in legislation. Note the privilege which attends his claims even in America.

In Great Britain in 1692 the tax on land was one fifth of its annual value, now it is about one fifth of that fraction. Landlords have thus grossly evaded their fair share of taxation. And note what horrid suffering and violences, often unpardonable, have been necessary to give Ireland such measure of land-reform as she enjoys to-day. The agitation against primogeniture and entail grows constantly in force in Great Britain, and the reform begun in Ireland and hastened there by differences in race and religion between landlords and tenants must of its justice spread to the sister island in time.

The complaint against property has, I think, been unduly directed against land, perhaps because land used to be the chief form of wealth. Real estate may present the most evident cases of abused privilege, but the main social difficulty, it appears to me, is the undue accumulation of wealth of any kind. The land of the world is certainly limited in quantity, but so are other forms of wealth: houses, mills, machinery, railways, and merchandise—all these, though vast in amount, are something short of infinite; and while land, as in America, is freely exchangeable for these other things, no special harm attaches to undue possession of it. And if it be said that these other things differ from land in that they can be indefinitely increased in amount, such an increase may be fairly compared with the settlement of barren territory in old countries, or of virgin soil in new. The forms of wealth other than land, while practically quite as limited in quantity, are quite as necessary to human life, so that, in their arguments against excessive

holding of land, political economists have perhaps paved the way for a more radical discussion of the rights of property than they ever anticipated.

No landlords have ever been more oppressive to a community, or levied more odious exactions, than the merchants and speculators who in the United States corner coal or pork, or the manufacturers who, secure in a close, protected market, combine to extort from consumers an exorbitant price for oil and chemicals. Canadian cotton-mills, which before the rise in the tariff, effected in 1878, were paying about eight per cent in dividends annually, since then have earned double and treble such profits at the public expense. The broad question of property, not the narrow one of land, is up for discussion, and it can not be dismissed with inadequate treatment. At the dawn of the present manufacturing era, in the days of Watt and Arkwright, about a century ago, there was a hope widely prevalent that the conquered forces of nature, acting through the ingenious machinery and processes so rapidly brought forth at that time, would greatly improve the lot of the poor. That hope, so creditable to the hearts of the men who entertained it, remains unfulfilled. The poor, it may be admitted, have been improved in condition, but have they proportionately shared in the enormous aggregate increase of national wealth? The development of the past century's manufacturing and trading industry in the existing moral and social circumstances has been attended by the constantly growing contrast between colossal fortunes on the one hand and the earning of a mere livelihood on the other. The masses toil as hard as ever, for all the steam-engines, the railways, and complicated machinery applied to every form of industry. The chief result, and certainly an unsatisfactory one, is that the luxury of a few increases. Within recent years palace-building has begun in America, and sums have been lavished upon the homes of railroad and mining kings to an extent equal to the making cheerful and wholesome whole quarters of cities occupied by the squalid tenements of toilers. With industry highly specialized, and becoming more and more so year by year; with the web of a credit competition continually increasing in complexity and liability, leading to panics more severe with every recurrence, there is manifest danger to property—danger, because these stresses of business entail suffering beyond description among the working-classes, and, under some sharp distress, they may make a savage and ill-considered attack on capital. Let Pittsburg and Baltimore justify the assertion.

Popular discontent has in all ages been a dangerous thing, but how much more so than ever now, when a numerical majority—that is, the poor—control legislation, elect the executive, and levy taxes! In the last analysis the rights of property depend upon the popular will, and the people can readily modify existing rights in what they may take to be the general good. Fourier and Saint-Simon did not speak to

a nation enjoying universal suffrage, nor were Utopias ever before preached to men who might practically attempt their establishment. The wide diffusion of popular knowledge through the schools, the press, and the platform, in these latter days, has made the discussion of such questions as that before us very general and very earnest. Workingmen's newspapers of wide circulation debate the *pros* and *cons* of the land and other problems fearlessly and with much good sense. The extension of the suffrage and the progress of political reform have taken such subjects out of the small circle where only speculative thinkers used to discuss them, and brought them home to the great masses of the working population, into whose hands the reins of legislation must more and more directly come. Trades-unions have made workmen sensible of the power of union and organization, and the benefits they have derived from their combinations have led to a wide-spread capacity for acting in concert scarcely known among them until this generation.

While in England and on the Continent of Europe property is much more unequally held than in America, it is evident that there are forces at work in the New World which are creating problems similar to those in the Old. Competent observers declare that wealth is passing more and more into the hands of the wealthy, the manners of the wealthy class are improving—they are gradually becoming an aristocracy in all but name; and, as the societies of the older cities become more and more cultivated, I think we may see a large proportion of wealthy families retaining their possessions for generations as they do abroad. It used to be thought that the sons or grandsons of rich Americans could be relied upon to give back to the community their inherited wealth through demoralization and incompetence; but that reliance is proved baseless in a noteworthy proportion of cases in New York, Philadelphia, and Boston. Fifty years ago the wealthiest man in America had a fortune of ten millions, let us say; now, the wealthiest citizen of the United States has a fortune estimated at from ten to fifteen times as much; and the proportionate increase in the extent of fortunes of the second and third magnitude has been similar. Has the wealth of the average citizen increased in anything like this degree? And such democratic social intercourse as we possess has its dangers—the intermingling in society in this country of people comparatively poor with those comparatively rich implants in those of restricted incomes a desire to live expensively, which would less often be the case were class lines as distinctly drawn here as they are across the Atlantic.

Into the question of the social advantages to a community of a very wealthy and leisured class I do not enter, but in passing would note that perhaps the worthiness and manliness, as a rule, of the British aristocracy have done very much toward their privileges being respected in these times of radicalism. And contrariwise, the sharpest

disgust against property has been expressed in the democratic far West, where refinement unpossessed of wealth jostles with the coarse ostentation of the bonanza kings.

The conquest of the weak by the strong, which must date from the very dawn of trade as from the first morning of life, has been more remarkable than ever within the last generation or two. The new methods of rapid or instantaneous communication bring vast commercial fields under the scrutiny of the keenest business intellects, and the local knowledge of the small trader is overborne in competition by the capital, adroitness, or unscrupulousness of his metropolitan adversary. Modern business economy favors vast organizations which absorb feeble competitors, and convert men who were independent principals into the servants of a master-will, whether controlling an individual firm or a corporation.

The danger to the public interest in the growth of great monopolizing companies is proved in the case of the Western Union Telegraph Company, which had nominally a capital of eighty million dollars a year ago, upon which it had to pay dividends. Nearly fifty-five of the eighty millions was, however, fictitious stock—water, in the language of Wall Street (see "North American Review," March, 1881). In the "Atlantic Monthly" for March, 1881, it is stated that the Standard Oil Company refines nineteen twentieths of the coal-oil of the United States, and robs the public of eight and three quarter cents per gallon by its monopolizing control. And what makes the abuses of property so difficult of legislative reform is that monopolists in their schemes avail themselves of business rules which, in their ordinary working, are legitimate, and can not be safely interfered with. If a Legislature enacts that a company shall not divide more than ten per cent annually as profit, that company is sold out to another, and both of them can pay dividends up to ten per cent. Competition is abolished by exercise of the right of purchase and sale, whereby competing railway, steamboat, or telegraph lines may be controlled by a single capitalist or syndicate; the operation being aided by banking facilities whereby stocks can be pledged as collateral security for loans equal to eighty or ninety per cent of their market value. The presidents and directors of great companies who organize such operations, and who have at all times special and early information of the influences likely to affect the value of their stocks, either directly or through agents, and the margin system, frequently add large sums to their fortunes at the expense of ignorant shareholders. The ordinary operator in Wall Street loses simply because he plays against men whose dice are loaded. The tendency to corporate and wholesale management so plain in the vast enterprises of the country is manifest in the less noticeable. In the Western States the factory-system has invaded the corn-fields: grand culture, as it is called, has come into vogue; large capital, elaborate steam-machinery, and regiments of laborers, are cultivating the

soil, and not scores of independent families with their personal interests and all the healthy influences of an independent, self-reliant struggle. In manufacturing and trading, as well as in farming, the strong large companies and houses are absorbing the weaker, and the fortunate ones who head the movement tend to become proportionately fewer as the process goes on. Every child now born into the world's theatre finds most of the best seats taken, and a good many of the second best. In all this I think there is danger, for which it is becoming necessary that preventives were thoughtfully sought.

Without deliberately facing the problem of *have* and *want*, there has been for ages a lurking, unconscious impression abroad that the differences in human fortunes are apt to injuriously widen—that the very poor have a moral claim upon the rich; that somehow, if human affairs were once to be placed on a basis of right, there would be none very poor, and so roundabout justice has for long been calling itself charity. The English poor-laws, dating from Elizabeth, which guarantee the natives of a parish support by the parish, is the most noteworthy example of this. Perhaps the next most striking example is our modern state education, which goes beyond the enforcing on a parent of his child's education—as it enforces its provision of food, clothes, and shelter—and, as it seems that these latter expenses are all the parent can usually bear, the child of the poor man is sent to school chiefly at the charge of the rich and well-to-do. The attempt at rectifying, however crudely, somewhat of the current social injustice, reconciles many to the measure who would otherwise oppose it on the high grounds of liberty and the inviolable responsibility which should remain with a parent—for why should bread not be given to the children by the state as well as books?

Besides public-school education, there have been many commendable attempts within recent years at reducing the glaring inequalities of fortune so common and so undesirable. Public parks, libraries, museums, picture-galleries, and hospitals have been established with public funds for the popular good; and wealthy men have given large gifts to them, recognizing the responsibility of riches and doing something for the toilers who have brought their accumulations together. Yet if we are to expect more of justice in the institution of property as time goes on, we may expect to see the circle of charity recede as opportunities for its exercise diminish.

Having briefly and very imperfectly stated some of the evils which attend the present methods of distributing and accumulating property, let us proceed to glance at the principal remedies suggested for their correction. The formal proposals for the righting of the wrongs of property have begun usually with land. In Great Britain not only reformers and philosophers, but parliamentary commissioners have again and again pronounced against the laws and customs of primogeniture and entail. These laws and customs are held to lead to unduly large

estates—estates so vast as to be unwieldy in management, interposing factors and stewards too often between landlord and tenant; these vast estates yield incomes culpably great and so enormous that their recipients are often indifferent to improvements in farming in comparison with proprietors of small farms, and much land is wasted by being held for mere sport. When the holder of an entailed estate quarrels with his heir, the land suffers, that the personal property which may be freely bequeathed may be increased. Such quarrels, if we are to follow the experience of common life, are usually due in part to qualities in the heir which would make him less worthy of the estate than some relative or kinsman to whom the holder might bequeath it were he free to use his judgment.

Mr. Kinnear, who has written a most sensible book on the subject of property in land, argues convincingly that the diffusion of property rather than its aggregation is desirable, holding that nationally property will be found to be accumulated more rapidly in the former case than in the latter, while at the same time comfort and content will be more common. He speaks from wide experience in Great Britain, France, and the Channel Islands. Mr. Kinnear suggests that there be limits placed to the amount bequeathable to an individual, so that very large estates may become divided. In common with the majority of competent observers, he prefers the French tenure of small parcels of land to the British tenure of great estates, but he regards the French compulsory division of the bulk of a property at a father's death among his children as wrong: were the father free to will to whom he pleased, the moral effect would be beneficial.

Children grow disobedient and unfilial when they know they can not be set aside. And speaking of wills, the custom of making what should be naturally one of the saddest events in life the occasion of coming into a father's estate is severely commented upon by the supporters of Russian and other communal systems of tenure. In the Russian *mir*, when a young man becomes of age, he enters into the enjoyment of a share in the common estate, and the effects of this difference are said to be observable in the stronger family feelings which the Russian peasantry cherish in comparison with their Western brethren.

The sad experience of King Lear and the painful presence of the gaping heir are both avoided by those sensible men of wealth who are their own executors to as great an extent as may consist with the reserve of a personal competence.

The individual holding of land as in France, Germany, England, and America, has been opposed by a great many thinkers and popular leaders. The chief objection lodged against it has been that land, being as absolutely necessary to human subsistence as air and water, it should be as free from monopoly as these; for as the accumulations of a single holder go on there is risk of his being able to drive people forth

where monopolists like himself do not exist, or, in conjunction with other such monopolists, order people off the face of the earth!

The second objection made to the present nearly absolute holding of real estate is that, particularly in America, and in Great Britain during the past century, the growth of population, the advance of manufacturing towns, and general progress in trade and commerce, have had the effect of enormously enhancing the value of land, increasing rents, without owners having given the community any equivalent whatever. Now, this unearned increment, as it is called, has bestowed upon some British noblemen and American land-owners many millions of value conferred by the mass of the people. This evident injustice is especially pressing in America, where there can be no doubt that, if the tenure of land remains as it is, the value of land apart from the improvements which labor may effect upon it, will be multiplied greatly within a century. Various remedies have been proposed to correct the evil.

The nationalization of land as suggested by Mr. Herbert Spencer has special reference to the United Kingdom. He would have the Government buy all the land from its owners at current market rates, and let it on competition. Mr. Fawcett, in his criticism of this suggestion, estimates the value of British lands and houses, apart from mines and railways, at £4,500,000,000. This enormous sum exceeds by six times the British national debt, and the raising of so large a sum as a loan in purchase would probably enhance the rate of interest one per cent beyond its present rate, and beyond the present rate of return received as rent. An annual deficit of £50,000,000 is calculated as the probable result of carrying out the proposal. Besides the special value attaching to individual possession, a value forming part of the current prices of land would be abolished when nationalization took place, and purely economic rents, minus the expense of an objectionable government control, would form the revenue to be credited against the interest on the purchase-money.

One of the leading pleas for nationalization of the land is the deprivation suffered by those who own none; but could not complaint be directed with equal propriety against lessors by all other citizens who would have to accept subleases? The sole benefit that could be hoped for from this scheme of nationalization would be the absorption in coming time of the appreciation in value due to increased density of population and other causes. This appreciation, if it takes place at all in the generations of the near future, is not likely to be other than moderate in the United Kingdom.

Mr. Henry George, of San Francisco, in his striking book, "Progress and Poverty," advocates much more heroic treatment of the evil of unearned increment. The constantly increasing tax of landlords, as tenants multiply and advance in industry, he regards as the main reason why a wedge seems to be dividing more and more widely the rich

and poor. In his distant State he has seen land taken up by speculators and held untilled for years, that it might advance in value by immigration—settlers by such action being far too widely scattered for their private good or the general welfare of the State. Taking the ground of natural right, and following Quesnay and others, Mr. George declares that except in the improvements due to labor no man can have a valid title to any part of the earth's surface. He therefore proposes a tax on real estate which shall be equal to its rental as unimproved land. In defense of this virtual confiscation in its results, he declares his opinion to be that his tax would render any other unnecessary, so that, in exemption from duties and other government levies, property-holders would receive a considerable palliative for the loss caused them by his discovery of the invalidity of their titles. The owners of town and city lots whereon buildings exist, and owners of improved farms, would retain the whole value of buildings and improvements, so as to be left with a large proportion of their former wealth. Objections bristle on all sides against Mr. George's proposal. First, he takes no note of the pretty general diffusion of real estate among the American people, property which all except a few of the whole population regard as real and substantial in a special sense. The confiscation of land, in past years freely exchangeable for other property and not generally held to-day by the enjoyers of very much unearned increment, would be resented by the common sense of the people; and the conscience of the needy classes, once weakened as to the validity of the tenure of one kind of property, might, under pressure of want in a commercial panic, indiscriminately attack all.

Most of us feel that the millionaires have too much even for their own good, yet any confiscation which might begin by depleting plethoric purses might end by larceny from very slender ones; and a movement ostensibly begun on grounds of public justice might, by additions of envy and the spirit of common theft, degenerate into wholesale pillage. Besides, how could a government like that of the United States be trusted with so vast and difficult a business as assessing all the land within its borders at its value—that is, at its market price, minus improvements? But the injustice of unearned increment in land remains with us still, and makes us wish that in America, on original settlement, the leasing for long terms had been established instead of absolute sale or gift by the Government; and also directs attention to the advisability of taxing the increase of value in land due to advancing population, say to the extent of one half such increase, in cases of depreciation just rebate being made. Some perception of the evils which Mr. George has beheld and would endeavor to correct, led a few years ago to the forming in Melbourne, Australia, of a land-reform society, which intended to urge on the Government the plan of leasing its lands instead of selling them to men who were reproducing in the colony some of the worst features of the English land-

tenure. In Java the Dutch Government leases plantations to a vast extent, and the plan works well there.

In Germany, the agitation against the existing laws and privileges of property has taken the form of socialism; the schemes of thinkers and closet-students have been popularized by press and platform until now the Socialistic party sends a large representation to the Reichstag, pressing measures upon the Government which a generation ago would have been deemed revolutionary. Much heated discussion has recently taken place in the national Legislature on the proposal that the Government should undertake the manufacture of tobacco; and if the state should manufacture tobacco acceptably and economically, why not cotton and wool? The beaucracy and strong paternal Government of Germany perform so many functions left in England and the United States to private enterprise, that the people in times of business depression look to the Administration for measures of relief instead of to their own efforts.

It seems to me that socialism is an evidence of the constantly rising dislike among the masses to the main advantages of competition and new business economies being enjoyed by the small class of capitalists. How far state control may allowably be invoked as a remedy in fields wherein individual exertions have been employed is a question warmly debated. One school of thinkers, led by Spencer and Bastiat, hold to *laissez faire*, and wish the operations of government confined to the narrowest limits—the maintenance of order and the enforcing of contracts—leaving individuals the utmost scope to think, express themselves, and act; the opposite school, among whom as an able exponent may be named Mr. Cairnes, hold that individuals, while following what they believe to be their interests, may not conceive their interests truly or in relations harmonizing with the general good, and that therefore some general control by the community of the actions of its several classes and members is most desirable for the correction of such practices and pursuits as are inimical to the whole body of the people, though pleasant or profitable to a few. This is said by Mr. Cairnes and others, not in advocacy of the general state direction of industry, but only in qualification of the sweeping theory that individuals, each doing his own work for its own reward, or seeking his pleasure in his own way, unconsciously contributes to the highest well-being of the community. Mr. Cairnes thinks the individual in society should be like a musician, who, in playing his part, looks chiefly to his own score, but occasionally glances at the central conductor so as to keep proper time with his fellows.

State socialism is not a living question in Great Britain or America; in Great Britain, however, the Government has notably added to its functions of late years: it has absorbed the telegraph service and the savings-banks into the post-office, and there is some expectation that the railways may also come under Government control. Mr. Brassey

believed that much waste of capital would have been prevented had Government controlled the English railways from their inception; unnecessary duplicate lines would not have been built, and their heavy cost in construction and maintenance would have been saved. Some forms of industry, like railway transportation, where free competition can be seen to lead to public waste, would seem to come appropriately under state control, provided that, as in Great Britain and Germany, the Government is administered honestly and intelligently. Advocates of state-controlled industry point to the danger, particularly in America, of railroad and similar monopolies robbing the people, but the people are not yet satisfied that their risks are not less as matters stand than if Washington officials bought supplies, constructed time-tables, and engaged the servants. Mr. Albert Fink, railroad commissioner, in ability and character the chief American authority in railroad questions, gave before the Committee on Commerce in Washington, last March, some very interesting explanations of the difficulties of railroad management. He showed that the intricacies of the business were plainly beyond the mastery of a government board, and he attributed the sources of such valid complaints as are made against railroads to their lack of mutual co-operation and good faith. He suggests the appointment of a commission to investigate the facts adduced in substantiation of complaints against railroads; such a commission, at the close of its labors, to recommend, if it thought fit, the establishment of a permanent commission for the best devisable supervision by the state of railroad transportation. Mr. Fink stated that a board of arbitration among the railroads themselves, with power to enforce agreements and maintain good faith, would abolish the main evils which beset the business. He drew attention to the fact that, while agitators desire to reduce the earnings of the few roads in the Union which pay more than the ordinary return upon investments to that rate, they are not desirous of making up from the public treasury the deficits met with in operating many of the lines of great public utility.

Modern business is unquestionably, in important departments, passing from individual to corporate management, particularly as the art of conducting companies becomes better understood year by year. Town and city corporations in Great Britain have long since absorbed with advantage the business of water-supply, and have, within recent years, successfully undertaken the manufacture and supply of gas; and why, if ten men agree to conduct a business, may not ten thousand, or the large majority of voters in a town, or, for that matter, in a country, resolve themselves into a company, if they think there are good prospects of profit ahead, and conduct any business whatever? Experience alone can decide whether the expectation of profit is baseless or not.

Less ambitious than state socialism, and more practical, is co-oper-

ation, which is fast revolutionizing British retail trade, but which is very slowly attacking the pressing problem of production. We can only expect the conflict of capital and labor to cease when labor, by thrift, has saved capital and participates in profits. To begin co-operative production, only picked men can be useful, for, in the present condition of workingmen, there is not generally diffused the intelligence and character necessary to selecting proper leaders and trusting them.

The difficulties of co-operation are the main difficulties attending the reforms of property. No laws or methods tending to replace a millionaire by ten men of a tenth his fortune may touch the question of how extreme poverty among the masses is to cease. The elevation of the poor chiefly depends upon themselves, upon their intelligence, their ascertaining the real conditions of life by a sensible plan of education, and then fulfilling those conditions by hard work and self-restraint. No people that spend $600,000,000 a year on drink can excite much sincere pity for their poverty. No people who marry without regard to their ability to maintain wives and children can look for substantial aid from Legislatures. Leclair, the house-painter of Paris, has demonstrated that honesty and forbearance are all that are needed, under available direction, for workmen to appropriate the profits they so heartily grudge their employers. Evidences abound that, when the time comes that workmen are fit for co-operation, able men from among their ranks will take their places at the head of manufacturing associations, and therefore the deprivations which are suffered by the present systems of employing labor await abolition with the development of conscience and intelligence among the toilers.

The material gain achievable by directly interesting workmen in the results of their labor must soon be expected to awaken among both employers and employed a desire to test, on a large scale, the partnership plan so eloquently advanced by Mr. Holyoake and others. If the profits now appropriated by the heads of great companies and firms are felt to be more than just, the moral condition which makes the profits so great is one which it lies with the contributors themselves to lift and improve.

Formal methods of dealing with the problems of property may be expected to do much less to equalize disparities of fortune than an improvement in social morality throughout all classes of the people. The great monopolists derive much of the strength of their position from a debased public sentiment, which condones their methods and admires their success. Often the shippers who complain against the tyranny of a great steamship or railroad line themselves practice rules similar to those against which they cry out; they take advantage of scarcity—at times an artificially created scarcity—to extort extra profits; and, as a railroad monopoly makes its traffic bear all it will, the little monopolist, in the shape of manufacturer or trader, makes his

customers pay him as much as he can, when circumstances give him the power of demanding unusual prices. An elevation in social morality would make conduct of this kind less common than it is, and would inevitably have some influence in restraining the greed of great monopolies. In America, with its limited past, wealth has an excessive social power, its pursuit is the business of nearly all the strongest intellects, and its marvelous growth in the country at large from year to year constantly tends to make it a more and more decided object of ambition. The ideal of a vast number of the people is wealth, and scarcely any price is thought too great to pay for it. If any improvement of this ideal is possible, it lies with teachers of morality and right thinking to effect it. Whether on the school-rostrum or the platform, in the pulpit or the editorial chair, or, above all, in the home, the aim of life should be taught to lie rather in the development of heart and conscience than in the accumulation of vast estates—more in the growth of honor and manliness than in the growth of those arts which gather wealth but stunt and paralyze the faculties of true enjoyment. The low idea of the subordination of life to the means of living is at the root of most of the problems of property. One of the chief impulses in the pursuit of wealth is the desire of obtaining public admiration and applause; if these are intelligently awarded much will be done to curb the unscrupulousness of those who gather together a great deal more than they can enjoy, in some cases heaping up sums far outbulking the accumulations of any previous age. And much will be done toward making efficient, in the prevention or punishment of the abuses of great properties, such legislation as may be applicable.

THE ETHICS OF VIVISECTION.

By Dr. SAMUEL WILKS.

SINCE many writers opposed to the practice of experiments on animals have based their objections entirely on moral grounds, and thus made the question of vivisection an ethical one, I have been anxious to know what laws they have discovered for our guidance on this vexed subject. They discourse on cruelty, on immorality, and on the rights of animals; but these expressions are so vague that they fail to afford any basis for legal or public action, or, if there be any attempt at definition, it is with the object of making these terms conform to a foregone conclusion on the very point under discussion. Thus it is constantly asserted that physiologists feel at liberty to torture animals at their pleasure, without regard to the "higher dictates of humanity" or to the "laws of morality." It is thus implied that there exists among the public some principle of conduct toward the

lower animals which has no place among experimenters. They speak as if, standing on a higher platform and beholding all creatures from a superior position, they could frame a code of laws which should have due regard to the rights of animals, and govern our own conduct in all our relations to them. This position is altogether fallacious: man can not disconnect himself from the animal world, and can not define its rights. It must, therefore, be abandoned as altogether untenable, and the subject discussed from a totally different stand-point. Our relation to the animal world can only in a very qualified sense be regarded from an ethical point of view; much in the same way as eating and drinking may be spoken of as questions of morality when moral considerations exert their influence over the amount and kind of food which we consume; this, however, can not hide from us the fact that the subject of digestion is fundamentally a physiological one.

The duty of man toward animals as an abstract question is from its very nature insoluble; it can only be partially answered on the grounds of expediency, and these will vary according to age and nation. We should, rather, ask what is our relation to the lower animal world, and in what place in that relationship can moral considerations come into force? In endeavoring to form a judgment of this relationship we must take facts as we find them, for the attempt at an explanation is trying to solve the riddle of our existence, and leaves us still with "the burden of the mystery of all this unintelligible world."

In seeking a solution of such a question as our duty toward inferior creatures, we must take into account man's animal nature; he is of the earth, earthy, and depends for his existence on the living world around him. Like many other creatures, he has to prey upon the lower animals for his subsistence, and although he may not often, after the example of some monsters of the deep, swallow small fishes by the mouthful —as in partaking of white-bait—yet, like the other carnivora, he hunts his prey and stealthily lies in wait for his victim. A large part of the existence of the lower animals is employed in search for food, or in protecting themselves from the assaults of their more powerful foes. Their exquisitely keen senses are put into full play to seek out their prey, or to place them on their guard against their more subtle enemies. Paley could discourse on the design manifested in the claws, teeth, and lithesome movements of the tiger, so well adapted for the capture of its victim, and with equal discernment portray the form and slender legs which enable the latter to escape its foe. It is necessary to picture Nature as we find it, or we may fall into the error which we see pervading so many recent writings—viz., that nearly all the miseries and pain inflicted on the lower animals arise from their connection with man. If we remember how many animals prey upon one another we shall realize the vast amount of pain and suffering ever existing among highly organized and sensitive creatures. None of us can measure the agonies of the slow death of an animal who has escaped mangled from

his enemy and been left to linger on a sunburned soil, with hunger unappeased and thirst unslaked. Most of us have seen the picture of the dying camel in the desert, glancing up with fearful eye at the vultures hovering above him; and the cat playing with the terror-stricken mouse is to many a familiar sight. Over other and grosser cruelties practiced by one animal on another, it would be best to draw a veil. A far pleasanter picture is it to contemplate the beauties of Nature, the glorious vegetation, the singing of birds, the gamboling of the lambs in the meadows, or the wild herds in the prairies; and yet there is no escape from the fact that animals practice toward one another nearly every human crime. There is the bright side of the shield, but there is the other which shows that "the whole creation groaneth and travaileth with pain until now."

Man, like other carnivorous animals, derives a pleasure from hunting his prey; and, indeed, many of the gratifications of life are dependent upon his animal instincts. In a primitive condition, while the woman is at home providing for the household, the husband is away in the forest or on the mountain seeking for food, and finding a keen exhilaration in the chase. In a higher state of civilization the instinct still remains; for, although the butcher may supply the meat, the sportsman still pursues the game; or if the fish-monger sells the salmon, the zest for catching the fish still exists. A man does not kill his own sheep for dinner, but he approves of the act; the most honest and guileless lady will not hesitate to eat the bird for the capture of which cunning and treachery have been employed. It would seem, from these examples, that a carnivorous animal like man can not frame a code of laws in relation to his inferiors, or determine the rights of the lower animals, on any Christian or other ethical principle, such as "to do as we would be done by." Up to recent times we have acknowledged no other law than "might is right." For I am not aware that society or the public voice has put any restraint on man's desire to kill whatsoever animals he pleases for his food; as for clothing, he may capture any creature he fancies, and steal the skin, coveting it the more the handsomer its coat; while society has not hitherto placed any limits upon his greed. We not only eat for necessity, but we foster and pamper our appetites, we breed creatures for our uses, and, when fit for our stomachs, kill them, doing also what humanity has never yet blushed at, first mutilating them and unsexing them. It has been truly said that in this sad world one of the greatest gifts bestowed on the animal creation is the relation of the sexes; and the singing of birds, the building of nests, the mating of animals, have given rise to much of the poetry of Nature. But it has been left for man to make herds of beef, and flocks of mutton, and horses whose only function is to drag our carriages. One might ask, in these sentimental and æsthetic days, whether one sigh of pity has ever been raised over these poor maimed creatures? What do those who talk of the rights of animals say on this

matter? or how does the ethical question apply here? Was the morality of the business discussed when nearly the whole family of whales was exterminated for the sake of their oil, or whenever troops of horses have been exported to engage in our quarrels and perish on the battle-field? If a horse could define his rights, would he admit the necessity of his going round and round in a mill the live-long day, or dragging a tram-car with the never-ceasing jangle of bells in his ears? Would the thousands of God's creatures in India approve of being called "vermin," and exterminated at so much a head? It is clear that, as regards food, clothing, mutilation, or work, there seems to be no other rule guiding us than "might is right." We have exercised the dominion given us over the beasts of the earth and fowls of the air as tyrants.

Now, when all this is said and admitted, we recognize over and above our animal instincts a higher nature within us—pity, love, compassion, and duty toward other objects; sentiments, indeed, which seem almost antagonistic to our lower life and to the proclivities of our fleshly body. This higher aspiration has ever been regarded as one of the best evidences of man's spiritual nature. We observe that a cultivated man is obliged to find a substitute to kill the sheep for his dinner, or to employ the necessary cunning to catch his game, since he could not practice deceit himself, nor nerve his arm to strip the Arctic animals of their skins to clothe himself. But although he does not imbrue his hands in blood, and although he dismisses from his mind the question of the animal's "right" to its own skin, he can not discard his own animal nature by appointing a substitute to perform actions in the result of which he participates. When, therefore, the question of the relationship between man and animals is considered, the fact that man is a killing and hunting animal himself lies at the very foundation of this relationship. Where, then, it may be asked, do the higher sentiments of which I have spoken come in? A ready answer is, that all these practices toward the lower animals are admissible and necessary for man's existence, but that *cruelty* should be avoided. This word, in common use of late, appears to signify the giving of unnecessary pain, but it still remains ambiguous unless the word "necessary" is defined. One may gather from various writings that "necessary" is equivalent to "advantageous to man"; for example, the word "cruelty" would be applicable to the case where a half-starved horse is made to drag a cart too ponderous for his strength, but it would not apply to the case of the same horse dragging a heavy cannon over a mountain for the safety and glory of the nation. What, then, is necessary pain, and what unnecessary pain or cruelty? If necessity is construed, as it is at present, to include not only the procuring of food, but man's enjoyment and general advantages, it is obvious that the question must have ever-varying answers. There are a few persons, vegetarians on principle, who would not kill animals for food under any consideration;

there are others who would not take their lives for pleasure. Past generations have approved of cock-fighting: there may be a future generation who will discountenance pigeon-shooting, and will regard that age as barbarous which could witness without disgust the bleeding carcasses of sheep hanging up in our most fashionable thoroughfares. The spirit of the age and the feeling of society for the time seem to determine what amount and kind of pain and suffering people will allow to be inflicted on animals and what they will disallow. The very valuable Society for the Prevention of Cruelty to Animals does not seem in its operations to offer a solution of the question. It would seem that most of the examples of cruelty which the society publishes are those where the public gain nothing by the act complained of, and can therefore afford to prosecute. For example, I have heard "shame" called on a carman who was endeavoring to make a horse draw a coal-wagon along the slippery pavement of Bond Street; and this exclamation came from a gentleman who on turning round might have seen the quails and larks closely caged for his table, and the dying and writhing lobsters waiting to end their miseries in a pan of boiling water. It would almost seem that the infliction of pain is allowable if approved by the majority, and that it is not allowable and constitutes cruelty if disapproved. In other words, cruelty depends upon the public estimation of its utility or inutility. One is forced to arrive at this conclusion, for the more one thinks over the rights of animals, or the ethical question of our treatment of them, the less does it appear that any considerations framed upon rights or morals have ever influenced mankind in its conduct. It is possible that some vague ideas respecting man's duty to animals may be floating through different brains, but those ideas have never become concrete.

It being admitted that man has a power, if not a right, over the lives of the lower animals, the question arises, Where should this right be limited, and at what point should our animal instincts, appetites, and wants be restricted? Utility or advantage seems to be the gauge used by the majority of persons. The question, therefore, between the anti-vivisectionists and their opponents appears to be a narrow one. The former assert that the pain inflicted on animals is out of proportion to the advantages obtained; Lord Coleridge says as much in his well-wrapped-up dictum. We, on the contrary, declare that the importance of experiments can be shown to be overwhelming in comparison with the pain inflicted on animals for this and other objects. The lofty phrase that "knowledge is unlawful knowledge if it is pursued by means which are immoral" must be analyzed to understand its meaning. As it is made applicable to vivisection, it is clear that "immorality" means "giving pain to animals"; and his lordship's statement would run, "All knowledge is unlawful if obtained by giving pain to animals." Whence it follows that, as it is allowable to give pain to animals for various purposes, it is only unlawful to give pain when the pur-

pose is knowledge. I see no other interpretation to put upon his words, and thus he places himself entirely at one with the rest of the anti-vivisectionists. These writers select out of foreign works all the horrible pictures they can find, and most unfairly ignore all those important experiments made by the aid of the most trifling operations under chloroform, and which have proved to be of inestimable benefit to animals and men. Lord Coleridge, although protesting against the charge of antagonism to science, unwittingly shows how profoundly he misunderstands the methods of scientific men, and consequently falls into the same error as his more ignorant friends. However little sympathy he may have with science, one would have thought that Whewell, Mill, Jevons, and others had clearly demonstrated that the methods of science can only be reached by accurate observation and well-devised experiment. I am afraid, therefore, that scientists will scarcely consider that man to be among their allies who believes their method is "to perform a hundred thousand experiments in the hope that some new fact may turn up." But this is only an example of the misleading nature of the statements and expressions of the anti-vivisectionists. This very term implies that their opponents are vivisectionists; much in the same way as, if a certain sect of vegetarians were to style themselves anti-sheep-killers, all the rest of the world would be sheep-killers, and this opprobrious word would be employed toward any lady who was seen eating a mutton-chop. The two cases are exactly analogous, for among the thousands of medical and scientific men who see the advantages of making experiments on animals there are scarcely twenty who would be willing to undertake operations of so disagreeable a nature. Just as the sheep-killers are those only who would protest against any laws being made to prevent them eating animal food, so in like manner the "vivisectionists" are those who maintain that legislation should not prevent a few physiologists performing the experiments which they judge necessary. What is asked by the vivisectionists is, that the whole power of the law should not be brought to bear upon a handful of accomplished men who are engaged in the service of science and humanity. They do not object to laws being made to prohibit incompetent persons from experimenting.

The difference between a dozen anti-vivisectionists and a dozen scientific men can not possibly turn upon a moral question such as dislike of cruelty; and, therefore, if the one can look upon an animal injured and bleeding with serenity and the other not, it would be owing, as the former party assert, to usage or habit. Let this be admitted, the converse is also true, and it may be safely conjectured that much of the opposition to experimentation is due to the unpleasant picture which the subject presents to the imagination. The difference between sensitiveness and compassion, or active benevolence, was long ago pointed out by Coleridge; but for this difference, Howard would be justly called the most hard-hearted of men. A lady shrinks with

horror from treading on a black beetle, but is only too satisfied to hear that the cook has exterminated the "vermin" by poison or boiling water. But lately an excellent example of a personal sensitiveness being mistaken for compassion has been witnessed in the case of the sale of the elephant. If the word of the Council of the Zoölogical Society can be taken as true, it was believed that "Jumbo" would be far happier traveling among his kin than leading a life of solitude in London. Yet, in spite of this statement, all the kind-hearted people have been sending their subscriptions to enable the society to forego its bargain, since they and their children can not bear to part with their favorite. It is like the frequent example of a mother preventing her son taking the voyage prescribed for the benefit of his health because her feelings can not allow her to part with him.

After eliminating all that is irrelevant and false, the question between experimenters and anti-vivisectionists appears to be a simple one. The latter declare that experiments are attended with great cruelty, and the results are of little or no good; they should therefore be disallowed. The former deny the truth of the proposition, and maintain that it is tyranny to put in force the power of the law to prevent a few, a very few, men of known reputation as trained physiologists performing occasional experiments, often unattended by pain, for the sake of advantages which they believe to be enormous. To endeavor to make vivisection a question of ethics, when moral considerations are altogether and confessedly ignored in a thousand other instances, is clearly illogical, and obviously prompted by an undue bias. In other words, the selection of the so-called standard of "morality," or of the "rights of animals," by which to measure the permissibility of physiological experimentation, is undeniably a prejudgment of the real point at issue. — *Contemporary Review.*

BORAX IN AMERICA.

By W. O. AYRES, M. D.

BORAX is now well known to occur in very many of the salt-springs in the Coast Mountains of California. But in only two places has it been found in large quantities: these are Borax Lake and Hachinhama (pronounced *Hah'-chin-ha'-ma*), both being in the immediate vicinity of Clear Lake, about eighty miles north of San Francisco.

Borax Lake is a shallow pool intensely of alkaline water, without inlet or outlet, and of course its extent depends on its reception of rain-water. After an exceptionally wet season it has a length of perhaps a mile and a half, with a depth of eight to ten feet; after an excep-

tionally dry season, on the contrary, it shows sometimes no water, the muddy bottom being covered with saline incrustations. When it has a length of three fourths of a mile, with a depth of four feet, being perhaps its average condition, the water holds in solution 18·75 grains of solid matter to the ounce—·039 of its own weight. This consists of salts of soda, in the following proportions: Sodium carbonate, ·618; sodium chloride, ·204; sodium biborate, ·178.

But this alkaline water, exceedingly rich as it is in borax, constitutes only a trifling part of the commercial value of the lake. In fact, it has never been turned to account at all in the manufacture of borax, though such use of it is entirely practicable, as the statements to be presently made in relation to Hachinhama will show. The muddy bottom of the lake was found, immediately on its discovery in 1856, to contain borax in crystals, in quantities most astonishing.

These crystals, being tested by various workers in iron and steel, were pronounced equal to the very best of refined borax. They are, in fact, pure biborate of soda, without any other impurities than the mud mechanically entangled with them in their process of crystallization. They correspond to the native borax of other localities, designated as *tincal*, but yet are decidedly distinct from it. In fact, no such crystals as those of Borax Lake have ever been found in any other locality, and there are several points in connection with their mode of formation, and even their very existence, which are by no means easy of comprehension, as we shall see.

Although the discovery was made, as already stated, in 1856, no practical development of the lake was begun until 1864. From this time it was pressed vigorously until 1868, when it ceased, not from failure of the supply, but simply from mismanagement of the work. The crystals were certainly less abundant at the last than in the earlier workings, but the lake still held and doubtless holds now an amount running to many millions of pounds, if it be not in truth practically inexhaustible.

Their abundunce was such, and the yield was so great, that within the period specified the lake had revolutionized the borax-trade of the United States; in fact, it had accomplished that work before the close of the year 1864. The annual importations since 1855, the earliest date at which the congressional reports enable us to trace them, had varied from $143,218 to $217,944. In 1864 they were suddenly reduced to $8,984, a result due entirely to the working of Borax Lake.

A statement of the manner in which the crude crystals were removed and utilized will bring to our notice the strange peculiarities of their nature, origin, and mode of crystallization.

The mud which constitutes the bottom of the lake is a smooth, even, plastic clay, of unknown depth. It has been bored through thirty feet without showing change in its structure. The upper por-

tion, for four and a half to five feet, holds unnumbered crystals; at that depth they suddenly and abruptly cease. Abundant explorations demonstrated that none were to be found any lower, and the daily working came to recognize the fact as established. The mud below that was saturated with the salts of soda, such as held by the water of the lake, but no distinct crystals existed.

The crystals of borax, in the upper portion, were removed by means of coffer-dams. Each dam consisted of a box, without top or bottom, four feet square and six feet deep, made of thin boiler-iron, suitably stiffened with surrounding bands of heavier iron. These dams, suspended above the water, between large pontoons or floats, were allowed to drop suddenly, whereupon their force of descent drove the sharp lower edge down through the soft mud and into that which was sufficiently firm and tenacious to resist the impact, and to render thus the iron walls of each a true coffer-dam, from which the entire contents could be easily removed.

The water was first pumped or bailed out, till it became too thick to flow easily, and the remaining mud was lifted in tubs, in true mining style, and thrown into large troughs, where, being subjected to constant agitation in streams of the lake-water, it was washed away, the borax being retained by its superior gravity.

No crystals were found until from twelve to fifteen inches in depth of the most fluid mud had passed away. The mud then began to feel "gritty," as the workmen expressed it, the "grit" consisting of multitudes of most exquisitely perfect minute crystals of borax. These crystals, like all those in the lake, were lying loose, detached from each other, attached to nothing by the base, and consequently perfect at both ends. It is not meant by this that every crystal was absolutely complete in every angle, but that they all had the tendency to the theoretical type, symmetrical at each end (a form which in artificial crystallization we scarcely ever reach, except by accident), and that many of them showed the type in full perfection, such as no model could excel or equal.

With every descending inch through the mud their size increased; the "grit" soon became "sand," in a few inches farther crystals were very manifest to the eye, and shortly a "layer" was reached. It is true that in some places no "layers" occurred, the crystals being scattered at random through the mud. But in most instances when from twenty-four to thirty inches of surface-mud had been removed, and the crystals had attained a length of one fourth to one half an inch, one or more "layers" would be found within the four feet square of the coffer-dam. In these "layers" the crystals were so closely packed as to have no mud intermingled with them; they were nearly as clean as though recently washed in clear water, lying closely stowed and loose, like pebbles on a beach. A "layer might be one to four inches thick and two feet, more or less, in length, surrounded on all sides by

mud which held only scattered crystals without any such richness as its enveloped pocket.

Going deeper, the crystals became constantly larger, though less numerous, as the mud grew more dense, until a stratum was reached which was designated "blue clay." In the mud immediately above the blue clay, crystals from one to two inches long were very common, though many of the smaller ones were still intermingled. Here a change in the crystals showed itself, full as well marked as the change in the bed in which they lay. The small crystals were not present; they had never been formed as in the mud above. Instead of them lay imbedded scattered crystals, few in number, but of great size, and having commonly a family look by which they could be recognized. Few of them were as small as two inches in length, and not unfrequently those weighing a pound each were obtained, being perhaps five to seven inches long, by two to four inches wide.

They lay imbedded in the clay, which was so firm that they could be picked out singly, each leaving the sharp mold which it had formed during its slow process of crystallization. They were all within a little more than a foot of the surface of the blue clay, many explorations showing that it was useless to seek for them at a greater depth.

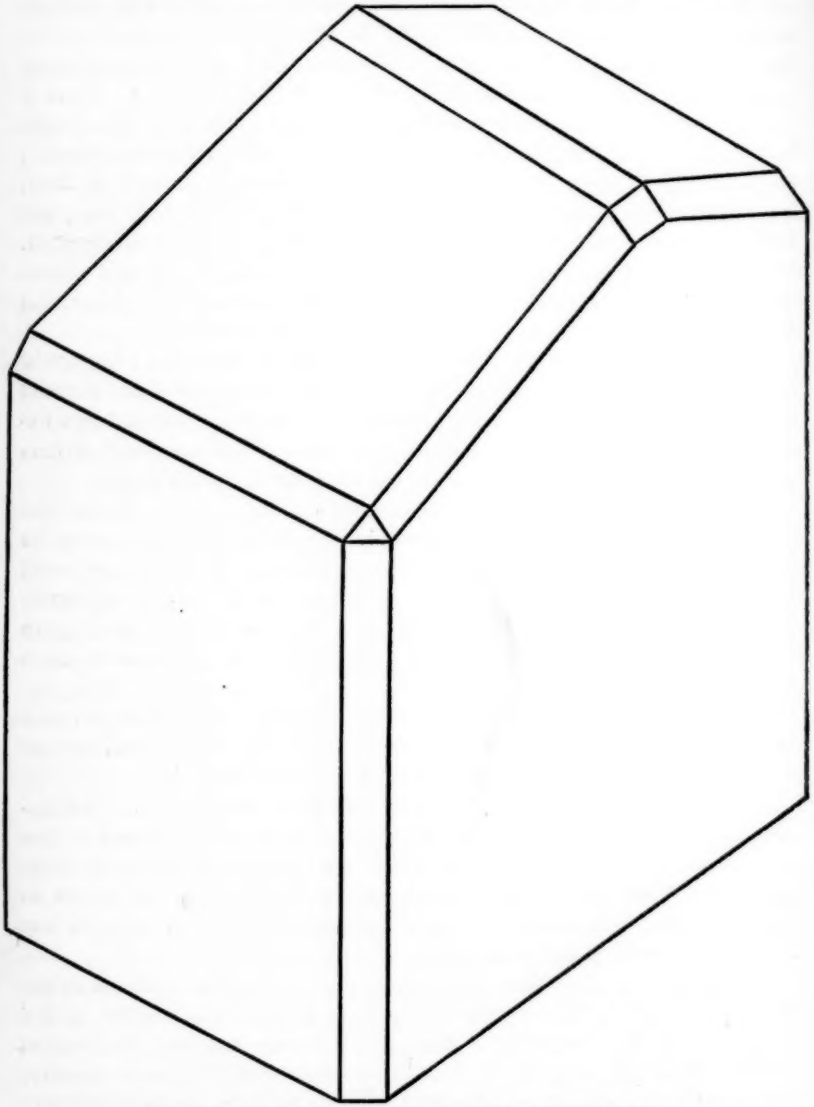
Of the abundance of the crystals within the portion of the lake occupied by them, a space of about forty acres, some idea may be formed from the fact that nine hundred pounds have been gathered from one dam, four feet square. And this by no means represents their full amount, as all the smaller crystals were washed back again into the lake in the process of their separation. At the same time it was remarkably true that the yield was very uneven. In what was known as "rich ground" barren spots constantly occurred, and often almost the entire yield of a dam came from one side or one corner, perhaps only a third or a fourth part of the full area.

The crystals thus obtained had a decidedly green color. The figure introduced is given for the purpose of conveying an idea of the size which the green crystals sometimes attained. It is not an exaggeration. I have seen many which weighed individually as much as the one here delineated. Their proportions were very erratic, but always conforming to the one type.

They were entirely free from the tenacious coating incident to the tincal of other localities; were readily and perfectly soluble in hot water, and in the process of refining by solution and recrystallization yielded their full weight of transparent borax of the finest quality, less merely the weight of the mud which had been mechanically entangled with them during their growth in a muddy menstruum. The green color disappeared in the refining, not being found either in the deposited mud or the new crystals.

We are prepared now to look at the origin of these salts as held in solution or in crystalline form. If, in a basin of water, more or less

shallow, containing a plastic soda-mud in the form of chloride and carbonate, deriving its carbonic acid from one source and its chlorine from another during its deposition, or, subsequently, fissures were opened



CRYSTAL OF NATIVE BORAX FROM BORAX LAKE, NATURAL SIZE.

in the subjacent strata, allowing the escape of a limited amount of jets of boracid acid from beneath in vapor, we should have all the conditions required to account for the formation of the borax in the midst of the two more loosely combined salts.

Thus far our way is plain. But whence came the enormous deposition of the green crystals of Borax Lake, their isolation and segregation in perfect crystallized integrity, and their continued preservation; while at the same time, in a solution almost identical in chemical composition, as we shall see, at Hachinhama, and in which often the proportion of borax to a given quantity of water becomes greater, no such crystals exist?

In most instances of salts crystallizing from a solution, the crystals attach themselves by a base to whatever material is adjacent, and when numerous they form a crystalline mass, from which the summits only of the crystals project—a crystal perfect at both extremities, and the sides not being common. And in Borax Lake itself, whenever the water has evaporated to such a degree in a dry season as to form a deposit from excess of strength, it has been an amorphous crust of carbonate, chloride, and borate, with no perfect crystals of either.

But the green crystals are isolated, and in thousands of instances are absolutely perfect, ends and sides. The large ones of the blue clay lie, as we have seen, each in its own mold. The smaller ones above lie often in layers, inches in thickness, hundreds of crystals heaped together as distinct from each other and as separate as pebbles on a beach.

Still, again, comes the strange fact that these crystals have been lying, how long we can not say, but almost certainly for very, very many years (for there is not the slightest evidence to lead us to believe that they are of recent formation), in a solution which makes no approach to saturation, and to whose influence as a solvent they seem totally indifferent.

The water of Borax Lake, when it has a depth in its main extent of five feet, which it often has for very many months and perhaps years in succession, holds in solution about half an ounce of borax to the gallon. During this interval, for four or five months of the summer season, its temperature is at no time lower than 55° to 60° Fahr. But water at that temperature dissolves a little over eight ounces of borax to the gallon. How, then, can the green crystals remain in such a liquid so long without being destroyed?

It may be supposed that the carbonate and chloride, in the complex mixture, render the hold of the borax so slight that, because of their presence, it is ready to separate. In reply to this suggestion comes the statement of the fact that when the same water is concentrated by evaporation to a specific gravity of 12° Beaumé, in which state it holds in solution six ounces of borax to the gallon, no tendency is manifest to the formation of even a single crystal.

Again, it has been suggested that, lying in a muddy menstruum, the movement of particles is so far arrested as to prevent diffusion, the stratum of water immediately surrounding each crystal becoming saturated and remaining unchanged. But this does not in the least

account for the commencement of crystallization, which, so far as we can judge, must have been in an exceedingly weak solution. Nor does it perhaps seem possible that such complete seclusion from ascending and descending currents could in any way be secured. The winter rains pour in quite fierce torrents of drainage-water from all sides, often rendering the entire lake decidedly turbid, and of course causing more or less of commotion in every part. And in addition to this is the diffusion of particles, caused by the changes of temperature throughout the year.

In whatever light, therefore, the question is viewed, it is not free from difficulties. And yet at the same time it is but right to recall the fact that these green crystals are in their nature tincal, though such tincal as has never been found elsewhere, and that the crystals of tincal are perhaps in other localities formed subject to the same conditions as here prevail.

We turn now to Hachinhama, the other locality mentioned, as affording the borax-supply of California. This is on the southern side of Clear Lake, about four miles west of Borax Lake, which it closely resembles in its features, though much smaller, being an oval lagoon about four hundred yards in length. We have, as there, a sheet of clear alkaline-water, with a bottom of soft, plastic mud. This mud has been bored to about the same depth as in the explorations at Borax Lake, without its lower limit being reached.

The evidences that the alkaline pool occupies the space of an extinct crater, are more manifest here than at Borax Lake, as the inclosing walls still remain, though abraded on their northern extremity, while on the south they rise abruptly to the great mountain-summit of Conoktai.

The water of Hachinhama holds in solution the salts of soda in the following proportions: Sodium carbonate, ·754; sodium chloride, ·083; sodium biborate, ·163. The mud throughout its entire depth is richly stored with the same salts, but without any development whatever of crystallization of any kind.

After the cessation of work at Borax Lake, in 1868, attention was turned to the resources of Hachinhama. Of course, the style of working must be totally different, for here was no borax ready formed, no green crystals needing simply solution and recrystallization. All that was available was a sheet of water, holding the salts above recorded. The problem, then, was to separate in purity the borax—the only one of sufficient value to be worth the effort—and leave the others.

Borax being the least soluble of the three salts, and at the same time much more soluble in hot water than in cold, it was argued that, were the water of Hachinhama sufficiently concentrated by boiling and then allowed to cool slowly, the borax would crystallize out, leaving the carbonate and chloride in solution.

This is correct in theory, and in laboratory practice the results

were entirely satisfactory, but in working large quantities the case was found very different. Concentrated to 20° B., a crop of crystals was deposited which were pure borax, but they were scarcely more than fifty per cent of the borax originally held by the lye thus formed. When, now, this mother-liquor was still further concentrated, no more pure borax separated, but a combined mass of borate and carbonate.

And here was manifested another feature. The amount of borax available depended very largely on the bulk of the solution in which it was allowed to cool. Very small quantities were of course useless in practical working, though the crop from them was satisfactory. Patiently continued trials showed that pans of two to three gallons gave economically the best results. But even here the borax clung so closely to the carbonate as to occasion much difficulty, until the plan was devised of crystallizing them together, and then washing away the carbonate by means of its greater solubility.

This was the plan adopted, and by its use about eighty per cent of the borax originally contained in the Hachinhama water, as pumped into the evaporating-pans, was secured. The extent of the works may be estimated from the fact that about 4,000 of the pans mentioned were in daily use.

But the unassisted lake-water was not long used. Hachinhama, from its shallowness, becomes nearly or quite dry at the close of each summer. As it dries away, the exposed mud is thickly covered with the salts deposited. These were carefully removed for use. The surface thus cleared of its salts began at once to renew its coating, the deposit being speedily replaced by capillary attraction from the stores beneath. In a week, or perhaps more, the surface was ready for sweeping again. The second crop was abundant, it was replaced by a third, and by others in succession, till the advent of the rains (never occurring in that climate till October, or perhaps November) put a stop to their formation.

This process was repeated each year during the occupation of Hachinhama, and, when the lake filled in turn with the winter rains, the alkaline-water bore the same degree of strength consecutively, showing that the stores of supply in the mud beneath gave no evidence of exhaustion.

The salts thus gathered were used by lixiviation to strengthen the lake-water in the evaporating-pans, and thus increase the yield of borax.

The work of refining the borax thus obtained differed in nothing from that employed with the green crystals of Borax Lake—hot solution and crystallization in lead-lined tanks. Hachinhama borax, as placed in the market, was of a grade of excellence never surpassed.

The works were conducted in this manner until the spring of 1872, when a change was introduced in consequence of the discovery that immense deposits of borates existed in Nevada. It was determined to

utilize the borate of lime, in the form of ulexite, for the conversion into borax of the carbonate of soda held in the water of Hachinhama.

The ulexite was brought by car-loads from the deserts east of the Sierra Nevada to San Francisco, and thence to Clear Lake, and a great increase in the borax yield of Hachinhama was the result. The process adopted was to saturate, with the ulexite, the boiling lye from the lixiviating tanks, before it had acquired sufficient strength to crystallize on cooling. A double decomposition was thus accomplished, resulting in a thick, milky-looking mixture which was an intensified solution of borax, rendered turbid by the insoluble carbonate of lime, this latter speedily settling and leaving the clear borax-liquor for concentration and crystallization.

Practically, however, this solution was never pure, for here came in again the same fact which had been demonstrated in the first workings at Hachinhama, that the bulk of the liquid in which the action took place had much to do with the chemical union accomplished. In laboratory experiments the work was perfect, and a boiling-heat of only a few minutes formed the full theoretical amount of borax demanded ; yet, when dealing with large quantities, this proved impracticable. Although violent boiling was long continued, even for hours, analysis of the lye showed that a certain proportion of the carbonate of soda still remained untouched by the boracic acid, and that, too, when the ulexite employed was in excess of the amount which careful analysis showed was sufficient to saturate the carbonate of soda present. And this excess was a necessity, and the daily working came to recognize it and to act accordingly, for, when the even theoretical quantity only was used, a much larger proportion of the soda remained untouched.

The operations at Hachinhama continued vigorously till 1874, by which time the enormous supply of borax brought into the market from Nevada had reduced the price to so low a point that further production became impossible. Hachinhama supplied all the American borax made from the cessation of work at Borax Lake in 1868 till 1873, and the two localities afforded between 1864 and 1874 all that was ever made in California. The yield of Hachinhama, during the last two years of its running, was something over 5,000 cases of 112 pounds each.

The immense stock crowding upon the market, which has reduced the price of borax to very nearly one fourth of its former rate, is commonly called "California borax," but that is a misnomer, originating in the fact that it has necessarily been shipped from San Francisco ; it is exclusively a product of Nevada. It is, in its look, so unlike the ordinary English borax, or that made at Hachinhama, that the contrast is very striking. Still it is practically the same, and has the same working value.

A glance at the map of the State of Nevada shows a large number

of dotted spots, individually of no great extent, scattered over the desert regions east of the Sierra Nevada. Most of them are without designation, but a few are marked "Soda Flat," "Salt Marsh," etc. They all have probably a common origin; they are places which long ago (how long we can not tell) were covered with water, since removed by solar evaporation. Each consists of an extent of entirely flat surface of dried mud, sometimes absolutely bare, sometimes covered with saline deposits. It had been known for years that these deposits were both what is there universally called "alkali" (carbonate of soda) and salt. But it was not until 1871 that much attention was drawn to the fact that several of them contained also deposits of borates, though published mention had been made some time earlier that these existed there.

The number of these "marshes," which are marked by borate deposits, it is impossible to state, as so large an extent of that arid region remains as yet very imperfectly known. A sketch of one, however, gives the characteristics of all.

One of the largest is known as the "Columbus Marsh." It is situated in Esmeralda County, about two hundred and fifty miles nearly due east from San Francisco, and about one hundred and sixty miles south of Wadsworth, on the Central Pacific Railroad. The portion last abandoned by the water, and now covered by saline deposits, extends about ten miles from east to west, and three from north to south, with an extension on the south into Fish Lake Valley, forming an arm fifteen miles long by one to three miles wide. Not all parts of this extent are equally rich in salines, neither is the character of the deposits the same at different parts, though it must have formerly been covered with one sheet of water, of presumably a uniform quality or nearly so.

A space of several hundred acres in one part, for instance, is covered with a crust of chloride and carbonate of soda, through which the foot breaks at every step; but the black mud beneath is filled to the depth of six to twelve inches with borate of lime aggregated in nodules, which, when broken open, show a beautiful pearly-white mass of satiny luster. These are the ulexite, and are commonly called "cotton-balls." They can be picked out by hand like the kernel of a nut, separating clean and clear.

Immediately adjoining the ground thus rich in ulexite is a wide stretch barren of everything, except a little chloride and carbonate. Just beyond this come five or six hundred acres, thickly covered with borate of soda, so little contaminated with sand or anything else as to crystallize out, by simple solution, eighty per cent of its weight in pure borax. Over vast extents of this surface I have seen the crude borax in its granular, semi-crystalline form lying from fifteen to twenty-four inches in depth, while, at the distance of a quarter to half a mile, the borate of lime was in similar abundance. The supply of borax

thus indicated is manifestly sufficient to fill all demands, far into the future years, and this refers only to that which is now on the surface; while the experience gained at Hachinhama seems to show quite conclusively that, were all the present store removed, its place would be refilled with a new crop drawn from the inexhaustible resources beneath.

To explain the manner in which these separate deposits have been formed is not easy, though in relation to the two borates the following suggestions may possibly be of some avail: If in a broad, shallow, mud-bottomed lagoon, the sodium of which has already formed its combinations with carbonic acid and chlorine, we imagine the process of evaporation to continue until instead of water there remains merely a muddy mass, so far viscid as to be unable to flow from one point to another, and that into this mass boracic acid is forced from beneath in jets, here and there, only in limited areas, and not extending beyond them, and if we imagine, still further, that the supply of boron is not sufficient to displace all the carbon and chlorine, we should have carbonate and chloride existing, intermingled with borate of soda, precisely as we in fact find them, and with a lime-mud we would have the ulexite.

This may perhaps answer for the borates, but a much greater difficulty is encountered when we propose to ourselves the question how the carbonate and the chloride crystallized separately. Over the chief extent they are blended, as they would be left by the evaporation of a lake which held them both in solution. Yet it is also true that, here and there, in areas separated from each other by no elevations whatever, and which have evidently never been separated, but which must have been parts of the same lake, vast beds of pure salt occur; while, perhaps, a quarter or half a mile away, carbonate of soda is lying in equally great quantity. How can these masses have been thus placed? Their bulk demonstrates that in each case quite a considerable depth of solution, even in its most concentrated form, was absolutely necessary. They could not have existed in such juxtaposition and have retained their chemical integrity.

Could the deposits have been formed at different times? There is nothing to indicate it, nor is the difficulty made less by answering this question in the affirmative. The chloride, in a blended solution, would of course be the last to crystallize, yet there is nothing to cause us to believe that over the carbonate-beds a mass of salt was once formed and subsequently removed. Neither can the two salts be crystallized in bulk, from a united solution, by any means with which we are at present acquainted, and left in the state of separate purity, in which countless thousands of tons are now lying on the deserts of Nevada.

The question is as difficult as the one why the mud of Borax Lake is filled with the green crystals, while that of Hachinhama has none.

The points concerning the combinations and the crystallizations in the Californian localities, and in those also of Nevada, I can vouch for personally. The facts are as set forth. I have mentioned nothing which I have not myself seen. The questions which are left without answer are certainly worth investigation.

PROTOPLASM.

By FRANCES EMILY WHITE, M. D.*

AT the recent International Medical Congress, held in London, upon which the attention and enthusiastic interest of the whole medical world were for the time being centered, Professor Huxley, in an address made to that assembly, used the term "medicine" to include "the great body of theoretical and practical knowledge which has been accumulated by the labors of some eighty generations"—that is, during the entire period since the dawn of scientific thought in Europe. In justification of this broad application of the term, he says, "It is so difficult to think of medicine otherwise than as something which is necessarily connected with curative treatment, that we are apt to forget that there must be and is such a thing as a pure science of medicine—a pathology which has no more necessary subservience to practical ends than has zoölogy or botany." In other words, there is a science of disease and an art of healing, both of which are included in the term "medicine," and, as all art is applied science, it is easy to see where the study of the "healing art" should begin.

Pathology is abnormal physiology, or, more broadly, biology, the science of living matter; living matter being recognized by its innate tendency to undergo certain changes of form and to manifest certain physiological phenomena which are universally recognized as constituting organization and life. When these changes of structure or of function become injurious to the organism, or cease to promote its general well-being, they are pathological, but the line of separation is not a distinct one; it is impossible to say with exactness where physiology ends and pathology begins.

It is evident, then, that the science of disease is a branch of the general science of life; and the distinguished lecturer, in making so wide an application of the term "medicine," no doubt intended to assert that the science of biology rests upon the broad foundation of the general physical sciences. The study of medicine, then, consists primarily in the study of biology, including those abnormalities of

* Address delivered at the opening of the Thirty-second Annual Session of the Woman's Medical College of Pennsylvania.

structure and perturbations of function to which living matter is liable; and, secondarily, medicine deals with the applications of the knowledge thus acquired for the checking of these perturbations and the renewal of normal structures—in other words, for the relief of suffering and the restoration and preservation of health.

The field of medicine is, then, a large one. As already intimated, some knowledge of the various natural sciences is essential to its successful study; not only by reason of the fact that living matter is subject to the same chemical and physical laws as non-living matter, but also because of the intimacy of its relations to its physical environment, and of the constancy of the reactions between every organism and its environment.

As a general introduction to the course of medical study now opened in this college, it has therefore seemed appropriate to devote an hour to a brief biography of *Protoplasm*, the universal life-substance from which all organisms, whether vegetable or animal, originate, and modifications of which constitute even the most complex tissues of the highest animal forms.

Though so universally diffused, though the autobiography of protoplasm has been written in the life of every plant and animal since creation's dawn, it is still a hidden story in some of its earlier chapters. Perhaps it is the very simplicity of its origin that balks us: we would fain invoke some supernatural explanation of the growth-force and the capacity for development which belong to this substance, as distinct from non-living matter, forgetting that all natural forces are equally elusive and obscure. Why do certain kinds of matter always crystallize in certain fixed and characteristic forms? Why, on the other hand, is protoplasm formless, but capable of endless development and change?

There are certain chemical and physical differences between crystallizable and non-crystallizable substances which, if fully understood, would no doubt furnish an answer to this question.

Protoplasm, a non-crystallizable substance, is both physically and chemically of a highly complex composition not determined with exactness, but known to consist mainly of hydrogen, oxygen, nitrogen, and carbon, variously combined in such proportions as to produce representatives of three classes of chemical substances—the albuminoids, the starches, and the fats—the albuminous constituents largely predominating in native undifferentiated protoplasm.

With these compounds is associated a considerable though varying proportion of water, as well as smaller quantities of saline and other crystalline substances.

Of the molecular structure of living, active protoplasm, nothing definite is known; it is, however, probable that the albuminoid matter of its massive molecule is associated with a complex fat and with some form of starch; while the water and the salts may be loosely combined

either physically mingled or perhaps weakly held together by the feeble chemical affinities which belong to all massive molecules. This constitutes a slime-like mass which, like all chemical compounds, exhibits certain characteristic reactions by which it is clearly distinguishable from certain substances, and known to be closely allied to certain others.

Protoplasm has the power of absorbing water in varying quantities, so that it is sometimes soft and nearly fluid, and again hard and leathery, though ordinarily of a medium consistence and density best described by the term "slime-like" already employed. It is then a glairy, tenacious, semi-fluid substance, transparent, and generally colorless; and if not quite the homogeneous, structureless matter which it was long supposed to be, there is at least an entire absence of differentiation of structure quite comparable to the observed absence of localization of function. When it acts it acts *en masse* or indifferently, sometimes in one portion, sometimes in another, of its substance, for the production of its simple movements and for the bringing about of its protean forms. Now all mouth, and anon all stomach, at times all feet, and again all lungs, it fulfills Dryden's famous description, "Everything by starts, and nothing long," save that it is ever and always *protoplasm.*

Like other albuminous substances, it is coagulable by heat, by alcohol, and by mineral acids, and is similarly stained by iodine and by nitric acid. Living protoplasm possesses also certain fundamental properties by which it may be distinguished from dead protoplasm. Prominent among these properties, grouped under the single term "vital," may be mentioned first, excitability, or, as it is more commonly called, "*irritability,*" by which is meant the power of responding to a stimulus. An amœba suddenly brought in contact with some foreign body responds to the stimulus so received by certain characteristic movements.

The movements of protoplasm, however, can not always be thus traced to some external exciting cause. Watching a specimen beneath the microscope, portions of the mass may be seen to creep, or rather to flow, slowly away in fine threads uniting with other threads from different parts of the same mass, thus forming an irregular net-work. Or perhaps it thrusts out temporary feet indifferently from any part of its surface by means of which it creeps slowly about, and it draws them in again, returning to the somewhat globular shape which appears to belong to its quiescent state. These movements are spontaneous; that is, they originate in the mass and result from the essential constitution of this kind of matter; therefore protoplasm is described as "*automatic*" or self-acting, and even as having a will of its own.

The internal changes which bring about these movements are believed to be identical with those which occur in muscle-tissue under stimulation, producing the change of form in muscle-fiber known as

contraction; hence protoplasm may be said to be "*contractile*," and this is another of its so-called vital properties.

Protoplasm also feeds upon nutritive material brought into contact with its surface. This it does by flowing around the substance, whatever it may be, which serves for its food, thus inclosing it in a temporary stomach improvised anew for each occasion, and becoming gradually obliterated as the new material slowly dissolves and is absorbed, mingling and chemically combining with the already existing protoplasm, and thenceforth forming a part of its substance. In other words, certain kinds of dead matter called food are assimilated, converted into living protoplasm by those processes of absorption and chemical union which constitute nutrition in all living things. Hence, protoplasm is "*assimilative*," and this is another of its vital properties. Side by side with this process of taking in new material and converting it into its own substance, there is also another process going on—that of rejection of old, broken-down, effete matter which has not only become useless to the living protoplasm, but would be injurious if retained.

The life of protoplasm is thus seen to consist in a double series of chemical changes, by one of which its substance is constantly renewed and built up; by the other, it as constantly breaks down, the products of decomposition being gradually rejected from the living, ever-fluctuating mass, which thus becomes the theatre, the arena, of life.

What is the outcome of this constant play of chemical and physical forces—this incessant interchange of matter between the mass of protoplasm and its environment? In other words, what is the meaning of the life thus manifested? Its significance is this: *The production and manifestation of new and higher kinds of force than any belonging to inanimate, inorganic matter.*

In the life of protoplasm we behold the dawning of voluntary motion—of those spontaneous movements especially characteristic of animals (though shown to a slight extent by plants as well), and exhibited in the highest degree by man in the thousand muscular adaptations displayed in his complex mechanism.

But the doctrine of the correlation of forces formulates the fact that the amount of force in the universe of matter is constant and unvarying; that, as matter is indestructible, so the forces which it manifests are persistent—never increasing, never diminishing. Whence, then, comes this new and higher kind of force called spontaneous motion? It is a law of physics that, as elemental molecules aggregate to form those which are more complex and massive, the force previously manifested by the simpler molecules becomes potential or latent, as it was formerly expressed; and that in the breaking down of these more complex molecules, in their return to their former simple state, this hidden force springs into activity again, not necessarily reappearing, however, as the same kind of force; there is not only a storing

up of energy, but a transformation, a remolding of it in other and, in the case under consideration, higher kinds. As the wide and rapid vibrations which constitute the expansive power of steam are made, by means of suitable mechanical appliances, to disappear in condensation and to reappear as locomotion, so the potential forces locked up in the molecules of protoplasm appear in the breaking down, the decomposition, of these molecules as spontaneous movements of some portions of the mass.

The energy expended in the movements of protoplasm is supplied through the chemical changes going on in its substance, by the breaking down of compounds possessing much latent energy into more simple ones containing less such energy.

These downward chemical changes are mainly processes of oxidation, one of the chief products of oxidation being carbonic-acid gas. Now, the taking in of oxygen and the giving out of carbonic acid together constitute respiration ; hence protoplasm is "*respiratory*"—another of its vital properties. It breathes, as the fish does, by absorption of oxygen from its surrounding medium ; but it breathes at the entire surface of its mass instead of at special parts of its surface, as in the fish. This is true of vegetable as well as animal protoplasm, the two being indeed regarded, in all essential points, as identical.

Protoplasm is also "*reproductive.*" Haeckel, in his history of the discovery of the monera, which consist of little globules of simple protoplasm, describes their mode of reproduction as follows: "The little creature divides into two halves, and each of these goes on living like the original one."

But there is a form of living protoplasm even more simple, if possible, than the moneron of Professor Haeckel—the *Myxomycetæ*—of which a very good description may be found in the inaugural address of Professor Allman, President of the British Association, in 1879, published in the October number of "The Popular Science Monthly" of that year. These organisms consist, during the greater part of their lives, of simple protoplasm. They may be found in moist places growing on decaying leaves, rotten wood, etc., etc., over which they spread in the form of a net-work, exhibiting amœboid movements, appearing to be sensitive to the light, and giving other evidences of life.

But we may find a specimen of protoplasm even nearer home than this. Prick your own fingers, if you choose ; withdraw a drop of living blood from the wound, and, having properly diluted it, place it under your own microscope for observation. Scattered among the numerous small bodies which give to the blood its brilliant crimson hue, may be seen a few somewhat larger colorless ones—the leucocytes or white cells.

These microscopic bodies consist mainly of simple, undifferentiated protoplasm. They differ from the monera (first found by Haeckel floating on the surface of the Mediterranean Sea) in being nucleated ;

that is, they contain a central kernel, the nucleus, which is more dense than the surrounding protoplasm, and of a slightly different chemical composition. These bodies, which circulate among the tissues with the blood forming a part of it, manifest independent movements, thrusting out and drawing in portions of their mass in true amœboid fashion; they devour solid particles of matter which come in their way—their smaller comrades, the red corpuscles, not always escaping their voracity. This they do by flowing around and inclosing them, as already described. They have also been observed by Klein to multiply by division, like the monera. The white blood-corpuscle, identical, apparently, with the amœba, which may be found in the standing water of pools attached to the surface of leaves, and in many other similar situations, is a true cell—the morphological unit from which all organisms, whether low or high, originate, and by whose multiplication, development, and differentiation, all the tissues of their bodies are produced.

The history of the growth and development of every animal—whether moner, mollusk, or man—is a history of cell-multiplication and cell-differentiation; and the most highly endowed individual of them all possesses no property, no faculty, no power, which is not at last foreshadowed in the formless, structureless, protoplasmic cell from which they are all alike derived. Is the nervous tissue of man in the highest degree irritable and automatic—that is, sensitive and self-acting? So is protoplasm, though in an almost infinitely less degree. Is muscular tissue eminently contractile, serving for the production of the varied and complicated movements of all parts of the body? Protoplasm is also capable of slight spontaneous motions of its entire mass. Are the various glands of the body actively secretory and excretory? So is protoplasm within the narrow limits of its chemical necessities. Equally, also, with the highest tissues and organisms, it reproduces its kind.

The complex body of any one of the higher animals may, then, be considered as consisting of certain tissues, each of which has not only been derived from protoplasm but each of which corresponds, in its perfected function, to some one of the fundamental properties of protoplasm, to the special manifestation of which it is devoted for the benefit of the organism as a whole, on the important principle first spoken of by Milne-Edwards as the physiological division of labor. Division of labor among the tissues, however, as among the members of a community, has its limits. While every tissue has some leading quality, some special function, developed to the highest degree in the interests of the organism as a whole (contraction in muscle-tissue, secretion in gland-tissue, and so on), yet each tissue retains in its own private interests, as it were, vestiges of all the other protoplasmic properties belonging to their common ancestor. Hence, all the tissues are assimilative to the extent of keeping up their own nutrition; all are

to some degree irritable, all are capable of reproduction of their own kind of cells, and so on.

Thus, from the beginning of his career, as a microscopic speck of living matter, to its close, although he figures as the most highly endowed and transcendent of beings, man, biologically considered, is *protoplasm, protoplasm, only protoplasm;* and, whatever his perfections, regarded as a member of the animal series, he has the high privilege of knowing if not of feeling himself the brother of all living things. With Job, he may say unto the worm, "Thou art my mother and my sister." "Oh, why should the spirit of mortal be proud?"

"What, then, *is* protoplasm?" we are inclined to ask, almost at the close of our attempt at a description.

Professor Huxley has called it "the physical basis of life"—an expression which has become classic in the scientific world—while life, in its turn, is defined as a property, or congeries of properties, of protoplasm. Pflüger has naïvely said, "Albumen lives"—that is, becomes protoplasm—"when it begins to take in oxygen"; and Foster, with equal simplicity, remarks, "The whole secret of life may almost be said to be wrapped up in the occult properties of certain nitrogen compounds."

Lewes, in his own graphic style, has said, "The organism and its environment are the two factors, of which *life* is the product."

Protoplasm is the agent by which the energy of non-living matter is converted into that of living matter—the sacred fire which is never permitted to go out, but perpetually glows on the altar of Nature, fed by the vestal forces of the environment, and burning ever higher and higher through those twin influences, heredity and the survival of the fittest.

This true "vital spark" is not only transmitted from generation to generation in the entire animal world, each reproducing its own kind, but it has been handed on, through vast geological ages, from branch to branch of the animal tree, since that far-off period when the "dawn-animal" first left its imprint in the hardening mud of its slimy bed at the bottom of a vast ocean whose waters were still under the influence of the earth's heated interior, when this ocean was overhung by a sky dark with clouds so dense that day and night were scarcely distinguishable, and shutting in an atmosphere heavy with carbonic-acid gas.

The relations observed between the fossil animals thus far discovered, the existing animal series, and the embryonic forms of all animals at the various stages of development of their respective embryos, are most significant. The earliest, oldest known fossil (the *Eozoön Canadense*, or "dawn-animal," the genuineness of which, though denied by some, is more than probable) belongs to the same class of organisms as the moneron and the amœba of to-day, which stand at the bottom of the scale of animal life; and the geological ladder in its ascent bears upon its successive rounds fossils which correspond, with

more or less exactness, to the ascending series of now living forms; showing, however, in addition to these, many connecting links between existing classes, which, in the progress of time and development, have diverged widely from each other; while the modern science of embryology as clearly shows that the development of the human being—beginning in a formless, structureless, microscopic speck of protoplasm, comparable in all appreciable respects to the "dawn-animal" of the Palæozoic period, and to the moneron and amœba of to-day—consists in the ascent, step by step, with a good degree of exactness, both of the geological ladder and of the trunk of the animal tree whose branches represent all existing forms of animal life, whose roots are deeply imbedded in the inorganic crust of the earth, and at whose apex appears the *genus homo*—the crown and consummate flower of organic development. In other words, the individual development of every human embryon is a brief *résumé* (in which, it is true, some of the chapters are suppressed and others greatly condensed) of the history of the development of animal life on the globe, from its infancy to the present day.

In 1862 Professor Graham pointed out the importance of the two states of matter, described by him as crystalloid and colloid—crystal-like and jelly-like. He says: "The colloidal state is, in fact, a dynamical state of matter; the colloid possesses energy, and may be regarded as the primary source of the forces appearing in the phenomena of vitality."

Although certain colloids have a very simple chemical composition (as silica, for example, which, ordinarily crystalloid, is capable of existing in a colloidal state), the molecular constitution of the colloids in general is undoubtedly highly complex. The molecule of albumen (a typical colloid closely resembling protoplasm), while it consists of but six different chemical elements, is estimated as containing several hundred atoms of these elements, which thus render the molecule an extremely massive one.

Now this massiveness of its molecules confers upon protoplasm a certain mechanical stability favorable to the preservation of organic forms; at the same time endowing it with the chemical instability essential for the constant exchanges of material which constitute nutrition and are characteristic of all living matter.

These massive molecules are also reservoirs of vast amounts of energy of the kind long known as potential—a term which, though likely to vanish, not into thin air but into the thinner ether, is nevertheless a very convenient one. This potential energy, stored up during the slow processes of plant-life and appropriated by animals in the form of food, is liberated or manifested as actual energy in the decomposition of their tissues—that is, in the gradual breaking down of tissue-cells, by means of which the animal functions are performed, and carbonic acid, urea, and other excretory compounds are produced.

But a large part of the tissues which make up the bodies of adult animals have, in a great measure, lost their resemblance to the protoplasm from which they were derived, through an extreme development which has resulted in tissues quite unlike each other—some of them, as the bones, for example, evidently serving a purely mechanical purpose in the body; and it may be said that a comparatively small proportion of the tissues of the body are, strictly speaking, living. Professor Beale classifies all the material of the tissues, and even of the ultimate cells from which the tissues are derived, under two heads, as *formative* and *formed*—that is, matter which has the power of producing new matter like itself out of pabulum or food, and that which has no such power, but which has been produced by the former. He considers that a muscle-fiber is not, like the protoplasm which produced it, living; and that the nerve-fiber also consists of formed material of which protoplasm is the builder.

In accordance with this view, only the lowest—that is, the nutritive—processes can be regarded as truly *vital*. The higher functions performed by the perfected tissues—the bones, the muscles, and the entire system of nerve-fibers and nerve-centers, including the brain—are mechanical rather than vital; the character of the function in each case depending on the character of the mechanism, i. e., on the particular relations of the parts concerned.

Muscle-tissue, for example, has but a single and simple physiological property, the power of change of form called contraction, and even this is a function of formed material rather than of living matter; but, through the mechanical relations of bones and tendons, of joints and ligaments, of associated and opposing individual muscular bundles, all the complicated and varied movements of the body are brought about.

The action of muscle is one and the same, whether it be expended in the grosser movements of locomotion, in the finer manipulations of the skilled artisan and the musician, or in the still more delicate adjustments of the vocal cords, by means of which the exquisite modulations, almost infinite in variety, of the voice of a Patti or a Campanini are produced.

These various adjustments are evidently mechanical in their nature. The so-called *vital* processes — processes identical with those taking place in the simplest animal that lives, and in the very grass beneath our feet, perform a comparatively humble part in the production of the vast results. The vital processes are concerned in the building up of the tissues and organs produced by and from protoplasm out of the food supplied to it; and the chemical changes involved in the breaking down of the tissues furnish the initial force in each case; but the actual forces manifested are due to transformations of this initial force brought about by the complicated mechanism which this force serves to set in operation.

The powers and possibilities of protoplasm may be crudely compared to those of steam, the expansive property of which may be observed in a simple apparatus for the grinding of coffee, for example, or in the operations of a magnificent Corliss engine, by which all the complicated machinery of an entire Exposition may be set in motion. The steam has precisely the same properties in the two cases, but the resulting forces differ in proportion to the complexity and multiplicity of the relations of the parts of which the different mechanisms are respectively composed.

In the study of the highly complex mechanism, the human body—which constitutes the study of medicine—all the powers and properties of matter must be duly considered and taken into account, for all are concerned in the production of its forces and in the performance of its functions; not one is violated or turned out of its natural course, but all combine in a harmony more complete than is manifested by any other known combination of materials and forces. Heterogeneousness the most extreme, complexity the most intricate, actions and reactions the most delicately balanced, all unite, in the play of the forces of the body, in the production and manifestation of its varied powers.

The study of science in any of its numerous departments is intrinsically elevating and ennobling if it be pursued in the true scientific spirit, viz., in the desire and search for truth for truth's own sake; and, while the pursuit of medicine has its practical side in preparing its votaries for the service of suffering and sick humanity—perchance for making the blind to see, the deaf to hear, and the lame to walk—it also broadens and enriches their own individual characters and lives, since it leads them into the green pastures by the still waters of the eternal truths of nature, at the same time bringing them into the still higher experiences of sympathy and charity toward all mankind.

THE MECHANICS OF INTERMITTENT SPRINGS.

By Dr. OTTO WALTERHÖFER.

THE springs called thermal springs are found in all latitudes, at various elevations above the sea, and in most of the geological formations. The word *thermal* does not, however, denote a spring of any particular degree of temperature, and is far from signifying that the springs to which it is applied are all equally warm; for any spring is thermal, the water of which is warmer than the mean annual temperature of the place where it occurs. In the equatorial regions, where the mean annual temperature is about 80°, a thermal spring should have a temperature of about 85°, while in the northern parts of the

earth, as, for example, at Yakutsk, in Siberia, where the year's temperature does not exceed 13°, it need be only a little above that. The waters of thermal springs maintain an equable temperature, and must therefore come out of depths in the earth at which the variations in the temperature of the air exert no influence. According to Boussingault, this depth in the tropics is only a little more than one or two feet, but between 48° and 52° of north latitude it is between sixty-six and ninety-three feet below the surface. Besides the springs that are called thermal, many springs are found the temperature of which exceeds the highest mean temperature of the year, and are called warm springs. Examples are the spring at Carlsbad, 167° ; that of Wiesbaden, 158° ; those of Baden-Baden, 154° to 111°, etc. The depth from which the waters come may be approximately calculated by the rule that the temperature increases one degree for every ninety feet below the surface. Hence the water of the bubbling spring at Carlsbad is supposed to come from a depth of seven thousand three hundred feet.

A third class of springs, the boiling springs, geysers, or hot springs, whose temperature is near the boiling-point of water, are peculiar in respect to the places where they appear. They are found only in volcanic regions ; are numerous in Iceland, where there are more than a hundred of them ; on the North Island of New Zealand, where they are most abundant in the neighborhood of the Roto Mahana, or Hot Lake ; and near the Yellowstone Lake, the Fire-hole and the Madison Rivers, in the region of the Wind River Mountains, in the United States, where some eight hundred of them are grouped within a certain well-defined area.

Among the hot springs, those which are intermittent, or the flow of which is uneven, are regarded with particular interest. Their waters are of a crystal clearness, with a slight tinge of green, and contain in solution considerable quantities of silicic acid, which frequently is deposited, in consequence of the evaporation of the water or the lowering of its temperature, as sinter. The most thorough investigations of the phenomena of intermittent springs have been made at the great geyser at the foot of the Bjärnafell in Iceland. Sartorius von Waltershausen,* Descloiseaux, † and Bunsen, ‡ have made extensive observations upon them, from the results of which, and of their own observations, Mackenzie, Bunsen, and, more recently, O. Lang, have formed theories respecting the mechanical causes of the intermittent flow.

The Great Geyser is situated at a height of one hundred and ten metres (three hundred and fifty-seven feet) above the sea. The part accessible to observation consists of a straight cylinder, R, lined with siliceous sinter, S, Fig. 1, about three metres (or ten feet) in diameter,

* "Physisch-geographische Skizze von Island," 1847.

† "Comptes Rendus," tome xxiii, 1846.

‡ "Annalen der Chemie und Pharmacie," Bd. lxii.

and twenty-three and a half metres (seventy-six and a half feet) deep, which widens out above into a tunnel-shaped basin, B, from two to three metres (six and a half to ten feet) deep, and seventeen to twenty metres (fifty-five to sixty and one half feet) in horizontal extent. The walls of the basin are formed of a cone of siliceous sinter, S, from six to nine metres (twenty to thirty feet) high, and about sixty-five metres (more than two hundred feet) broad. The water of the geyser is crystal-clear, with a greenish tint, and flows, except immediately after an eruption, steadily over the rim of the basin. A double motion may be perceived in the column of water inside of the cylinder. A hot stream ascends from the bottom in the axis of the cylinder, while the cooler water descends by the sides, but only to about half-way down, for it there unites with the rising hot current and ascends again to the surface. The temperature of the water is 179° at the surface of the basin; rises at the bottom of the basin to 192°, and rises in the bottom of the cylinder to 251° and 260°. The peculiarity of the intermittent streams consists in the fact that their waters mixed with steam are forcibly thrown up in huge jets at longer or shorter intervals. At the Great Geyser, jets of steam, accompanied by detonations raising the water to the height of about ten feet, appear in different parts of the basin at intervals of from one and a half to two hours. At intervals of from twenty-four to thirty hours, a column of water, mixed with steam, rises over the whole extent of the cylinder and the basin, with a sound as of distant thunder, to a height of from twenty-five to thirty metres (eighty to ninety-three feet), and scatters clouds of spray. After an eruption of this kind, the duration of which is about ten minutes, the basin and cylinder are empty; they are gradually filled up again in the course of from four to six hours, after which the processes described above are repeated. The loss of water occasioned by the eruption and overflow is made up for by side-streams, a part of which, W, being near the surface, probably bring in cold water; others, W′, entering at the bottom, water of a higher temperature than the boiling-point.

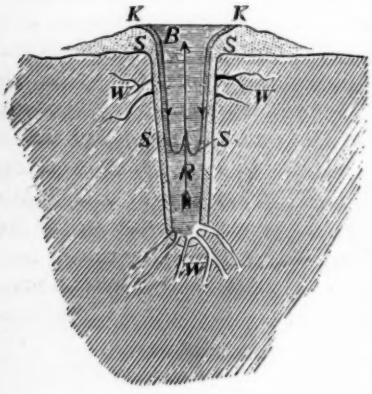


FIG. 1.

The following theories have been advanced in explanation of the periodical eruptions of the Great Geyser, and of the phenomena of intermittent springs generally:

According to Mackenzie's theory, a hollow space, *b*, Fig. 2, exists in the interior of the earth wherever an intermittent spring occurs,

the walls of which are formed of thick stone, free from penetrating clefts. Water-ways entering it from above and from the sides bring in cool waters; while other streams bring up from below water heated to above the boiling-point, or steam from the volcanic foci. The inferior conducting power of the rock-masses, inclosing the chamber

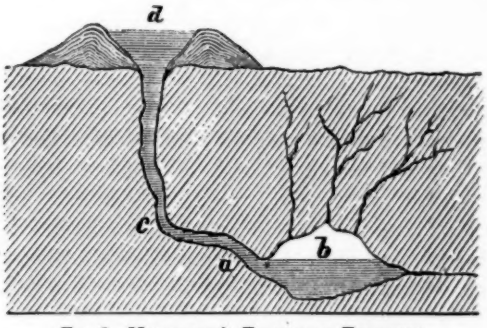


FIG. 2.—MACKENZIE'S THEORY OF ERUPTION.

and the stream-channels, prevents any material diminution of the temperature of the steam and the water, so that the chamber, *b*, becomes filled with hot water and steam. By virtue of its levity, the latter collects in the upper part of the chamber, while the water covers the bottom, and at the same time, as it is added to by the constant inflow from the canals which enter the chamber, *b*, rises and shuts up the tube at *a*. The steam is thus deprived of an outlet, and, since it is continually compressed into a smaller space by the constantly increasing mass of water, is added to by the entrance of new steam, and is heated to a higher temperature by the heat brought in with the hot water that keeps flowing in; it on its side exercises upon the surface of the water in the chamber a pressure that, increasing every moment, gradually raises the water in the tube, *c*, and causes an overflow over the rim of the basin, *d*. Finally, the pressure of the inclosed steam becomes so powerful as to overcome the absolute weight of the mass of water in the tube, *c*, and throw it up strongly and suddenly in fountain-like spouts. After the steam in *b* has relieved itself, and the pressure on the water has thereby been diminished, *a* becomes again closed up by the rushing back of the water from the tube and the flow of water from the chamber, and the conditions requisite to another eruption are produced. The temperature of the water in the chamber and in the tube rises continually between one eruption and another, and reaches in many places the degree at which steam is formed. This is the case in the lower part of the tube at *a*, where, the water nearer the chamber having a higher temperature than in other parts of *c*, the steam rises in *c* and causes the bubblings which appear in the basin at intervals of from one and a half to two hours.

This theory, which supposes a subterranean cavity acting as a kind

of steam-boiler, has now very few adherents, since Bunsen has given an explanation of the phenomenon that makes the supposition of a cavity in the interior of the earth unnecessary.

Bunsen gave his sagacious explanation of the periodical eruptions of the Great Geyser after observations and researches which he himself undertook in the year 1846. He found that the temperature in the geyser-tube, R, Fig. 1, is in a state of continuous increase between one eruption and another. Thus, if the whole column of water, R, is divided into layers of a specified thickness, one of these layers, for example, at a certain depth below the surface would show immediately after an eruption a temperature of 187°, which would rise after an interval to 188°, and then to 189°, etc. The more deeply situated layers would have a higher temperature at first, which would increase in the same manner. In no layer, however, would the temperature at which water is changed into steam be indicated before an eruption. The passage of water into steam—that is, its boiling—does not take place under all circumstances at 212°, but only when the pressure on its surface is equal to the weight of one atmosphere, or fifteen pounds to the square inch. If the surface in question is exposed to a lower or a higher pressure than this, water will boil at a correspondingly lower or higher temperature. Thus the boiling-point is depressed as we ascend mountains and enter regions where the pressure of the superincumbent atmosphere is less than fifteen pounds to the square inch. Conditions also exist in nature in which the boiling-point is raised to more than 212°, and may be found, for example, in the intermittent springs. To return to the tube R in the Great Geyser (Fig. 1), the water in which we have divided into a number of horizontal layers: a greater weight is put upon each successive layer in the descending series, since each one has to bear the weight of all the layers above it in addition to that of the atmosphere. Water, the temperature of which exceeds 212°, is called superheated. It has the property of being convertible instantly into steam as soon as the weight laid upon it is removed. Bunsen turned this physical behavior of water to the explanation of the eruptions of the Great Geyser. The water brought up in the streams (W′, Fig. 1) is in a superheated condition on account of the depth from which it comes and the pressure to which it is exposed. It is not, however, converted into steam on reaching R, because that is prevented by the weight of the column of water above. The layers of water above it are, however, heated by convection from it, so that they become specifically lighter, and originate the axial current toward the surface. As soon as it reaches the surface, the water is cooled by radiation, and a part of it falls back in the shape of the downward currents along the sides of the tube, causing a depression of temperature, and a corresponding delay in the formation of steam. But these currents are weak, their water is gradually becoming warmer as it gets farther from the surface, so that they only reach about the middle

of the tube R, and fail to prevent the temperature of the whole water-column from finally rising under the influence of the constant flow of superheated water from the streams, W′. The strata of water in the middle of the tube finally reach the temperature of the boiling-point at that depth. This water is then converted into steam, and thereby the pressure upon the lower strata is diminished. Then the strata of water still deeper in the tube are also converted into steam, and this throws the masses of water above it energetically out of the geyser-tube. The water being cooled somewhat in the air, a part of it falls back in the tube, and, producing a reduction of temperature, causes a short interruption of the formation of steam, but that is resumed again as the superheated water flows in, and continues till the whole column has been so reduced in temperature, by the water that falls back, that the liquid strata no longer reach the boiling-point corresponding with the pressure upon them, and the eruption ceases.

According to the theory of Lang, the Great Geyser occupies a space in the interior of the earth in shape somewhat like Fig. 3. The tube

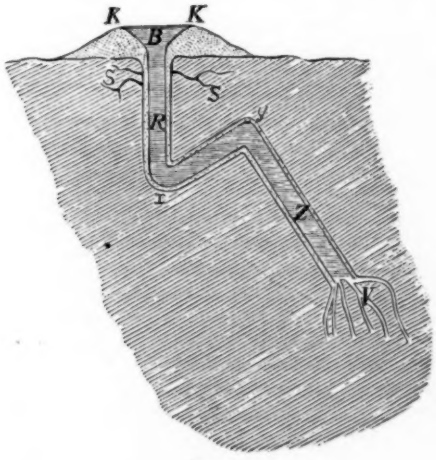


FIG. 3.

R, by which the waters are connected with the surface, is bent upward at x, to be bent downward again at y into the tube Z, which, reaching the depths of the earth, is connected with the channels V. These channels conduct to Z hot water mixed with steam, while R is supplied by the streams S, which lie near the surface, with cold water. The geyser-tube becomes stopped at x by the accumulation from these two sources, and the steam rising from Z, deprived of an outlet, collects at y. Its elasticity being augmented by the masses of steam that keep coming up, and by the continued accession of heat from Z, it forces away the water that is in contact with it, and gradually fills the connecting passage xy and a part of Z, while it interposes a separation

between the water-columns R and Z. The water in R becomes heated by contact with the imprisoned steam, and will obviously attain a higher temperature in the lower than in the upper part of the geyser-tube R. Superheated water is produced in R as well as in Z, because the weight of the water in R and the upward pressure of the water, and the confined steam in Z, produce pressure and counter-pressure. As steam and water continue to rise from the channels V, the level of the water in $x\,y$ is depressed, for the steam can exercise its force only in the direction of R. As the expansive force of the steam increases, a greater quantity of water is driven over the rim of the basin till the force of the steam becomes so great as to exceed the weight of the column of water in R. Single puffs of steam escape, the elastic force of the vapor is slightly diminished, and a sudden development of steam is produced from the superheated water in Z, causing the whole column of water in R to be thrown forcibly into the air. The superheated water which has got into R during this movement is likewise converted into steam, increasing the effect. The conditions required by the last theory for the origin of an intermittent spring exist in nature. Volcanic forces produce suitable crevices, and the water, leaving siliceous deposits upon the walls, makes these clefts steam-tight.

The time which elapses between two successive eruptions varies in different intermittent springs. It depends upon the length and breadth of the whole geyser-shaft, and the distance to which it penetrates toward the interior of the earth. The temperature of the superheated water and the amount of steam that is formed from it are also largely dependent on the size of the spring. Thus, Strokr and the Little Geyser, intermittent springs in Iceland, also lying at the foot of Bjärnafell, have much stronger eruptions than the Great Geyser. The intermittent springs of the North Island of New Zealand are distinguished by their beautiful snow-white deposits of siliceous sinter, within which the water of the basin appears blue. The most imposing of known geysers are those of North America, of which the Giant shoots its jet to the height of two hundred and fifty feet.

A PREMATURE DISCUSSION.

By Mrs. Z. D. UNDERHILL.

IN her clever article upon "Science and the Woman Question," in "The Popular Science Monthly" of March, 1882, Miss Hardaker arrives at the definite conclusion that woman is and must necessarily for ever remain the intellectual inferior of man. In view of the importance of this conclusion, it will perhaps be worth while for a critic committed to neither side of the question to point out several flaws in

Miss Hardaker's argument, which show that, whether or not her final conclusion be correct, the proofs and reasoning which she adduces to sustain it do not fulfill that purpose.

In the first place, Miss Hardaker brings forward prominently the argument that, as the brain of man is larger than that of woman, therefore his intellectual ability must be greater. But she omits to first prove that size is an essential attribute of superiority. Some of the most intelligent members of the animal kingdom have also, as far as actual size is concerned, the smallest brains. Excluding man, no other animals have elaborated for themselves such complicated social systems as have ants and bees. There are many similar facts which tend to show that size of brain has only a relative instead of an independent value, and scientific investigations have not yet been carried far enough to establish the physiological bases upon which this relative value of brains is to be estimated. It is quite possible that it may ultimately be found to depend upon factors of which we as yet know nothing.

The argument that, as man has larger stomach and lungs than woman, he must consequently have more energy and more mental ability, is equally without a base in any such accumulation of exact facts as must always be the only foundation for trustworthy inductions. The fact that the elephant and horse have also larger stomach and lungs than those of man has not enabled them to surpass human beings in that complex evolution of mental and moral qualities which we agree to denominate superiority. The real material causes from which such superiority proceeds we have yet to discover; and, while it looks at present as though relative size of body and brain might be one among them, we have no such positive proof of this as would warrant resting an argument upon it.

As to the other arguments founded upon the supposed inferiority of intellectual vigor in women, owing to the discharge of their peculiar physiological functions, it is only necessary to repeat that the solution of this question involves a knowledge of the complicated workings and balances of the human system which we do not yet possess.

The argument for the intellectual superiority of man, based upon the supposed superiority of his intellectual achievements, shows the same unscientific disposition to draw conclusions before investigating facts. The mass of the female sex has been engaged since the beginning of civilization in two functions—the regulating of household life and the training of children—both undoubtedly involving intellectual activity. Reflection must make it obvious that it would be impossible to arrive at a correct conclusion as to woman's mental powers by comparing her achievements with those of man in fields which, as a sex, she has never entered. In order to rightly estimate her brain-power, it would be necessary to discover by long-extended and carefully collated research the amount of intellectual ability involved in the discharge of those functions to which her energies and intelligence have

been directed. The observations of one person are of no value as a foundation for argument; but it would perhaps here be pertinent for the writer to mention that, in her own experience of life, she has seen women who have not impressed her as inferior in mental ability to the men with whom they associated, and to whom the exercise of their duties, as the heads of households and the guardians of childhood (involving the many questions, abstract and practical, which these duties do involve), has seemed to afford scope for the greatest intellectual activity.

Considering the want of knowledge, of all but the most fragmentary facts, which meets us at the threshold of this question, it would seem that all the arguments on either side are wasted breath, and that those advocates deserve reprobation who would throw a false veil of scientific reasoning over their ignorance. It is a sufficient sign that no real study of the question has yet been made, when we find on both sides suppositions and feelings brought forward as arguments.

The only way in which such a problem can be properly approached is by the scientific methods of study which are now applied to other subjects: the painstaking accumulation, from all available sources and by many collaborators, of all the statistics and facts bearing upon it, the patient search for such truths connected with it as we are still ignorant of, and the application to all alike of unprejudiced investigation and strict logic. This has never yet been attempted.

THE RELATION OF MUSIC TO MENTAL PROGRESS.

By S. AUSTEN PEARCE, Mus. Doc., Oxon.

THE nature of music is threefold, like that of man to whom it appeals. Therefore, it may be regarded as a sensuous art, in that it delights the ear; as a psychologic art, in that it records the emotions, and requires mental operations on the part of the hearer for its due appreciation; and, as it involves agreements, differences, symmetries, complexities, etc., and order in apparent disorder, it may be regarded as a branch of science closely allied to mathematics.

The distances between the holes of a flute, the tension of a drumhead, the lengths of organ-pipes, the rapidity of vibrations, the intervals between recurring accents—in fact, all that may be surveyed and expressed in numbers in this art—give evidence of the mental power of the musician, irrespective of all considerations respecting the imagination or creative power in originating compositions.

The music of a people may be considered in direct relation to their supersensuous natures. From this point of view alone, strongly marked differences may be noted; for, by comparing modern Italian

music with German, it is at once seen that the latter is developed more highly in an intellectual sense.

Our modern music is styled a new art, chiefly because it requires advanced mental powers of a special kind on the part of composers and auditors. Instead of being a succession of monotones, it is a complex web of many tones, that the hearer must analyze to understand and enjoy. In the ordinary church-quartet there are four such interwoven threads; in a symphony by Beethoven, many more. An elaborate tonal plexus demands from the listener considerable mental effort, unless he has acquired by study a "polyphonic ear," or the power of perceiving the relationships of all the parts heard simultaneously, as clearly as one, looking down upon a ball-room scene, may perceive the symmetrical forms of a mazy dance.

It is interesting to consider the birth of a new art, and gratifying to note that our modern civilization is marked by so rare an event. We need not, therefore, lament that at the Renaissance no specimens of Greek music were forthcoming; for these might have influenced the early composers, whose special duty it was to strive to express the new thought and feeling of the time, and of the Latin and Germanic races, not of Greeks or Orientals. When the mental sleep of the dark ages passed to the waking dream or semi-consciousness of the middle ages that led to the complete awakening, there was great productive activity in all branches of art.*

But, whereas, in architecture, painting, poetry, dancing, sculpture, dramatic representation, etc., models of classic antiquity were at hand, in the department of music nothing came to light but the didactic treatises of the Greeks. These works, which were printed in Holland in the original text and studied carefully by musicians, failed to exercise any marked influence on the art, for there were no actual compositions found that would illustrate the theories so carefully elaborated. Our modern art, therefore, is no Euphorion, born of a Faust and Helen—of Christian and pagan ancestry—for there was no artistic dualism in music at the Renaissance.

Although the Church had, in the Bible, a foundation for poetical and musical art, it neglected Hebraisms. Being reared on classic ground, its first hymns and poetic forms were Greek and not Oriental. But this early Church music could not supplant that which missionaries found in Western countries. Strong as the Church was, in many senses, in those days, it could not hinder the introduction and recognition of the new polyphonic style. In this one particular it seemed powerless to dominate over the free spirit of man that thus formed for itself its own mode of expression. The musician was left unhampered in his actions, while throughout the Renaissance there was a constant struggle between the styles of the mediæval artists and

* See article in "The Popular Science Monthly" on the "Imperfections of Modern Harmony," vol. xvi, p. 510.

the classic models of antiquity in all the other arts. To this day, music has, in a technical sense, remained free from all admixture with relics of the dead past; and, although some of these may be hereafter discovered, it is doubtful if they would prove more than merely interesting to those thinkers who are ever desirous of enlarging their conceptions of the art by studying that of other peoples.

Such specimens could hardly have any vital power, however highly they might be prized, being too foreign to the experiences and requirements of our age to find willing ears. And this not because sympathy with the emotions expressed would not be accorded, or that the few sounds of the lyre would not prove sensuously agreeable, but because the structure of the music, in the third sense mentioned above, would prove so strange.*

We can not here define the Greek scales, nor contrast Occidental music with Oriental, Gothic cathedrals with Grecian temples, dramas of Shakespeare or Kalidisa with those of Sophocles, as regards relative complexity and simplicity, but must proceed to point out that as civilization arose in the West, music at least kept pace with it, if it was not greatly in advance of the intellect of the time, as it is now, when even Beethoven's latest quartets remain as sealed books. It has been noted that it was an important factor in the general Western illumination, and was most truly of it, while the other arts were represented by specimens that were in it but not entirely of it. These arts of visible representation of known things requiring less mental power than the invention of new forms that have no counterparts in nature or geometry, it does not appear strange that, while painting, sculpture, and architecture attained highest perfection long ago, music continues to make rapid advances in several directions, to open new schools, to pass through various phases—now being developed in one direction, now in another—that this art is expected to reveal hitherto unknown possibilities in the future. We have already grown beyond the deification of the bodily man, and seek the mystic inner soul. This makes the art of music so greatly in requisition. Our successors may go deeper still, and altogether cease to make reproductions of tangible things.

The relation of musical art to literature and general progress may be seen illustrated in the recent history of Germany. After the Thirty Years' War, which reduced her to material, mental, and moral poverty, she began to establish the Protestant religion, and to try to form into one coherent state a number of small principalities. Her literature was the expression of the national spirit, and yet helped to form this spirit. Luther invented the Choral, which remains to this day, not only the song of the Church, but the national song of the whole united people, their political song, their war-song, and one of the mightiest engines for developing in the minds and hearts of the people the sen-

* See article on "Oriental Music," vol. xviii, p. 241, in "The Popular Science Monthly."

timent of universal brotherhood. "Nun danket alle Gott," which won the battle of Leuthen, during the late Franco-German War, proved its influence over the people to be unimpaired.

Music and literature thence went hand in hand down to the school of the Romanticists, in which the middle ages became the ideal, and appeals were made to the national pride of the German. Then Wagner produced art-works that are similarly founded on national myths, and are more ambitious in scope and intention, as well as in musical and dramatic structure, than any works of his predecessors. Let us now take a broader historic but a narrower musical survey.

The Church accepted the musical teachings of Pythagoras and the astronomical theory of Ptolemy; and thus, for some unknown reason, progress was retarded. When the world accepted what the Church rejected, progress began in both sciences. For Ptolemy had demonstrated a new "section of the canon," by which our modern major scale was scientifically determined, and justified, and which made our harmony possible.

The invention of counterpoint in the north of England in mediæval times, and the subsequent practice of canonic forms of imitation, led to the general treatment of music on scientific methods by composers, however it obtained among the populace. In China we find music among the uneducated classes as unlike that of the musical mandarins as can well be imagined.

Subsequently, the discovery of harmony in nature opened a new realm to the musician. It was a revelation. It provided him with a scale of sounds analogous to that of color in the spectrum, and he soon determined the proportions mathematically. Hence a new science arose within the art of music, by which the composer no longer proceeded by a kind of "rule of thumb," but with a perfect knowledge of the ratios of speeds of vibrations, at which sounds would combine to form chords, as chemists after John Dalton learned to make new compounds unerringly.

The musician followed up the soft whisperings of Nature, until he found that each tone was attended by myriads of other tones as truly as attendant planets, asteroids, etc., surround a primary sun.

Heretofore music was made to conform to certain laws of proportion when viewed horizontally on the paper, but now it was made to conform to another series of laws, when regarded horizontally; the art of fugue was seen to be one of the greatest triumphs of the human mind, and the great universities in England instituted examinations for degrees in music, making the projection of an eight-parted fugue or canon in silence the supreme test of the mental prowess of each candidate.

It is thought that the opera was intended to be a resuscitation of the Greek drama, in which all was to be elevated and made musical. The music, however, differed but little from the prevailing style. It

is also thought that at the Crusades, when we learned so much from the Arabians, in mathematics, etc., we also acquired their musical systems, which are marvels of ingenuity and complexity; but these were utterly rejected, and the Arabians, on their part, refused to admire the little we could then accomplish with the new science of harmony. So little did our music take its rise in the East (although all our instruments originally came from thence), that the Irish harps and harpers were sent to Italy, where they gained the praises of Dante and Galileo. The Italians subsequently sent their sons westward, to learn counterpoint, as Americans now study in Europe.

In early times music was much more troublesome to learn than it is now. The instruments were difficult to tune, and keep in tune; and the notes had to be identified by the ear. Now, a deaf or ignorant performer may provide himself with the tonal system ready-made and symmetrically laid out as on a piano-forte finger-board. The complex nature of the new art demanded such a simplification, and some arrangement by which an executant might operate many notes at the same time. The advances made in the physical sciences generally, and especially in pneumatics, hydraulics, electricity, and acoustics, aided in the improvement of organs.

The mere act of reducing the musical dream to positive statement in writing marks a mental advance, especially when it is remembered that this notation has proved capable of recording conveniently the most highly elaborated forms of modern compositions. It is far simpler than the Chinese notation, and more direct than tablature, which gave directions how to find the notes, instead of indicating them directly by letters that form a kind of algebra. With this notation the musician has been able to avail himself of the printing-press, and thus to spread his apparently indescribable imaginings broadcast throughout Christendom. Singularly enough, his harmonies are still unappreciated elsewhere.

The study of comparative psychology has been followed up. Hence we now find in the works of Chopin an ideal reflection of the sorrows of the Polish people, long suffering from quarrels not of their own making; and, in the passionate music of the Italian, a marked contrast with the deeper-felt expressions of his Teutonic neighbor. Modern introspection, as in Byron's "Manfred" and Goethe's "Faust," finds its counterpart in the overtures of Schumann and Wagner, whose "Faust Overture" is acknowledged to be a portraiture of a definite soul-state.

Although the drama has declined, modern music has become preeminently dramatic. A symphony by Beethoven is an idealized form of the Shakespearean drama, rather than that of the Greeks; for it has not a mere trio of parts, but many; and a complex scheme of plots and counter-plots, incidental passages, etc. Its voices are persons (in the sense of *personare*, "to sound through"), and they are heard

simultaneously, not merely consecutively. The Wagnerian opera, therefore, that employs both visible and invisible characters, shows an advance worthy our present attainments.

It was stated above that, while other artists are occupied with the tangible forms of the external, visible world, the musician is busily engaged in the study of the human soul; yet it must be remembered that he has had to seek for the germs of his art in nature, and that these were hidden from him so deeply that they were hidden long.*

His resonator must be constructed to re-enforce some particular note which he supposes to be sounding, whereas the telescope of the astronomer reveals many unsought objects at once. And while the painter finds his forms and colors openly displayed, the musician must evolve his from within. He creates both form and spirit, and so entirely, that we can form no notion of the smallest tributary melody in any work we have not actually heard, or the score of which we have not seen.

If our civilization endures or progresses, there can be little doubt that the music of the future will continue to give evidence of the fact, even if it should not contribute to the general advancement.

DR. GÜNTHER ON THE STUDY OF FISHES.†

MANY difficulties, says the "Quarterly Review," tend to prevent ichthyology becoming a popular study, as the study of shells, insects, birds, or flowers is popular. However it may be with the particular species that anglers seek out and professional fishermen hunt, fishes as a class are not familiar objects. They keep for the most part out of sight, and when at liberty in their element can be detected only by passing glimpses, after which they are nearly always immediately lost. The aquarium, whatever it may have done to aid the study of the lower forms of aquatic animals, has contributed little or nothing to promote a real knowledge of ichthyology; and a preserved specimen of a fish is a most unsatisfactory object, as far as it can be from having anything of the color or the life or the grace of a real fish, and can not by any possibility be made to present a natural aspect.

Another serious difficulty in the way of the student of fishes may be stated thus: In beginning the study of any department of natural history, whether it relates to plants or to animals, the first effort is to find out characteristics of the smaller groups composing it, and to

* See article on "The Modern Piano-forte," p. 700, October, 1877, in "The Popular Science Monthly."

† An Introduction to the Study of Fishes, by Albert C. L. G. Günther, Ph. D., F. R. S., Keeper of the Zoölogical Department in the British Museum.

assort them in accordance with those characteristics; in short, to arrange or classify them. The young conchologist, for example, sees in an instant that out of a miscellaneous collection of shells some are bivalve and others univalve, and that some of them exhibit clear distinctions connected with the form of the animal to which the shell belongs. The young entomologist, with still greater ease, perceives the difference between most of the insects that come in his way, and indeed in some cases needs no instigation to look for them—the difference between a grasshopper and a house-fly, a beetle, a butterfly, and a moth, being self-evident to any one with eyes. So with the vertebrates; it requires no previous zoölogical instruction to enable any child to point out characters that will separate a snake from a tortoise, a rabbit from a sheep, a whale from a camel, and the rough primary division of all these creatures is at once perceptible. But with fishes this is not so. The learner, judging, as he is at first inclined to do, from outward survey, is surprised to find that the essential differences between a lamprey and an eel are deemed to be far greater than between an eel and a salmon, and that a skate is much further removed from a turbot than the latter is from a gudgeon, while a lancelet, which, when immersed in a bottle of spirit, looks so like a small smelt, differs, in the opinion of certain systematists, more from it than the smelt does from a frog, or indeed from any other existing vertebrate. All this, which the learner finds written in the first book on the subject (if he has one of the least authority) to which he has access, is so entirely in contradiction, as he thinks, to the plain evidence of his eye-sight, that he may well be staggered at the outset of his studies and discouraged from their prosecution. The classification of fishes has in truth been a task of no ordinary difficulty, and it is a subject requiring a far greater knowledge of their internal structure than can possibly be expected of a beginner.

One of the most formidable difficulties in the way of arriving at an intelligent classification has been removed by a discovery which Dr. Günther has made concerning the affinities of certain groups of fishes or fish-like animals, the relations of which to each other and to other fishes had been an inscrutable puzzle to all systematists. Among these were the ganoids, a family represented in an indefinite number of fossils, mostly of very ancient date, but few types of which survive to this day, and these restricted to the fresh waters of Eastern Asia, North America, and tropical Africa; other fossil fishes of equal antiquity, which were closely allied to the abundant sharks, dog-fishes, rays, and skates of our own seas, the "Chondropterygians" or "Elasmobranchs"; sturgeons, "Chondrosteans," possessing much of an archaic character; and besides these, there now exist two animals, commonly called "mud-fish," scientifically "Dipnoi," which have been deemed by some great authorities true fishes, by others amphibians. Furthermore, in the early days of the settlement of the Australian

colony of Queensland, accounts were given of the existence in the rivers of the country of a large fish which the colonists called a "salmon," from the fact of its having salmon-colored flesh, and of sometimes, it was said, rising to a fly. Mr. Krefft, Curator of the Australian Museum, at Sydney, having examined a specimen of this fish in 1869 or 1870, pronounced it to be allied to the mud-fish, but discovered also that it possessed teeth so closely resembling those of certain fossil fishes attributed by Agassiz to the sharks, that no doubt could be entertained of the generic identity of the two forms. Accordingly, the newly found animal was described as a species of *Ceratodus*—that being the name which Agassiz had conferred on the creatures whose fossil teeth he had long before made known. Now, all this was in itself sufficiently remarkable, for it proved that *Ceratodus*, as a genus, had persisted from the Mesozoic era; but its important bearing was not fully perceived till after some more examples had been obtained and sent to Dr. Günther. He described the recent *Ceratodus* in great detail in the "Philosophical Transactions" for 1871, and was able, furthermore, by its means, to show how the palæozoic as well as the recent ganoids, the sharks and skates—both ancient and modern—the sturgeons, the mud-fishes, with some other forms that had hitherto been irreconcilable, could all be brought together through some essential characters common to the whole of them, and harmoniously placed in a single class, to which he assigned the name of "Palæichthyes"—fishes of ancient type. Professor Huxley had previously pointed out the affinity of the mud-fishes to certain ganoids, but the credit of discovering this comprehensive classification is due to Dr. Günther.

Dr. Günther does not undertake to describe definitely the geographical distribution of fishes in the sense in which the term geographical distribution is used by naturalists of other branches, he holding that "the endeavor to establish, by means of our present fragmentary geological knowledge, the divisions of the fauna of the globe leads us into a maze of conflicting evidence." It is obvious that fishes are not amenable to the laws of geographical distribution which govern land-animals. In treating of their relations in this respect it is, moreover, necessary to separate them into categories, of which Dr. Günther makes four: 1. Fresh-water fishes; 2. Brackish-water fishes; 3. Marine fishes, which are furthermore subdivided into shore-fishes and oceanic or pelagic fishes; and, 4. Fishes of the deep sea. Even in the case of fresh-water fishes, which of course live under conditions more similar to those of land-animals than do those of the other categories, he disallows the six great zoögeographical regions which most geologists have accepted, and would arrange them in three zones—Northern, Equatorial, and Southern. These zones, are, however, broken up into regions, which roughly correspond with the six generally received, except that the Australian region of most zoögeographers is split up into

two, the "Tropical Pacific" and the "Antarctic" region, the last including the Patagonian seas as well as those of New Zealand and Tasmania. The fishes of the second category (brackish water), owing to the fact of their living in salt-water equally with fresh, and thus being able to spread readily over the globe, can not help in any plan of parceling out the earth's surface into districts. The shore-fishes afford a somewhat better definition, and of them five groups are formed, which inhabit respectively the Arctic Ocean, the Northern Temperate Zone, the Equatorial Zone, the Southern Temperate Zone, and the Antarctic Ocean. The pelagic fishes seem to require separation, but as little can be deduced from them as from the inhabitants of brackish waters, and they insensibly mingle with the fishes of the deep sea.

Thirty years ago no one had the audacity to believe that the abysses of the ocean were tenanted with piscine life. Even animal life of any sort had been supposed to be impossible at a greater depth than that which has now been found to be but the portal of a new world of beings. The discovery of what has since been proved to be deep-sea forms of fishes began indeed long ago, but the abysmal nature of their haunts was hardly suspected, and certainly not recognized till much later, when the fact was established by Dr. Günther, conjointly with the late Mr. James Yate Johnson. On this subject Dr. Günther says: "The knowledge of the existence of deep-sea fishes is one of the recent discoveries of ichthyology. It was only twenty years ago, that, from the evidence afforded by the anatomical structure of a few singular fishes obtained in the North Atlantic, an opinion was expressed that these fishes inhabited great depths of the ocean, and that their organization was specially adapted for living under the physical abyssal conditions. These fishes agreed in the character of their connective tissue, which was so extremely weak as to yield to, and to break under, the slightest pressure, so that the greatest difficulty is experienced in preserving their body in its continuity. Another singular circumstance was, that some of the specimens were picked up floating on the surface of the water, having met their death while engaged in swallowing or digesting another fish not much inferior, or even superior, in size to themselves. The first peculiarity was accounted for by the fact that, if these fishes really inhabited the great depths supposed, their removal from the enormous pressure under which they lived would be accompanied by such an expansion of the gases within their tissues as to rupture them, and to cause a separation of the parts which had been held together by the pressure. The second circumstance was explained thus: a raptatorial fish, organized to live at a depth of between five hundred and eight hundred fathoms, seizes another usually inhabiting a depth of between three hundred and five hundred fathoms. In its struggles to escape, the fish seized, nearly as large or strong as the attacking fish, carries the latter out of its depth into a higher stratum, where the diminished pressure causes such an expansion of gases as

to make the destroyer, with its victim, rise with increasing rapidity toward the surface, which they reach dead or in a dying condition."

It was also shown that, as the same species and genera are found in the most distant parts of the globe, the deep-sea fishes are not limited in their range, and consequently, as is admitted on other grounds, that the physical conditions of the ocean-depths must be much alike all the world over. That the deep-sea fishes are not of a peculiar order, however peculiarly organized, but are for the most part modified forms of surface-types, was another conclusion arrived at from the scattered evidence available before dredging at great depths was systematically practiced, and a conclusion that has since proved to be right. Nevertheless, it still remained to ascertain more precisely the bathymetrical horizons in which the different kinds lived, and this has been to some extent attained by observations made during the voyage of the Challenger; but these can not be received without further critical examination, for, unfortunately, no precaution seems to have been taken to keep the mouth of the dredge closed, and therefore it is probable, if not in some cases certain, that fishes were occasionally entrapped while the machine was passing through the surface-water. On the other hand, the majority of the examples taken in the dredge offer literally internal evidence that they were inhabitants of the abysses, being so organized as to be unable to live near the surface, and consequently that they were captured at the greatest depth to which the dredge reached, or nearly so.

The physical conditions of the deep sea, affecting the organization and distribution of these fishes, are thus formulated by Dr. Günther:

1. "Absence of Sunlight.—Probably the rays of the sun do not penetrate to, and certainly do not extend beyond, a depth of two hundred fathoms; therefore, we may consider this to be the depth where the deep-sea fauna commences. Absence of light is, of necessity, accompanied by modifications of the organs of vision, and by simplification of colors.

2. "Phosphorescence.—The absence of sunlight is in some measure compensated for by the presence of phosphorescent light, produced by many marine animals, and also by numerous deep-sea fishes.

3. "Depression and Equality of the Temperature.—At a depth of five hundred fathoms the temperature of the water is already as low as 40° Fahr., and perfectly independent of the temperature of the surface-water; and from the greatest depths upward to about one thousand fathoms the temperature is uniformly but a few degrees above the freezing-point. Temperature, therefore, ceases to offer an obstacle to the unlimited dispersal of deep-sea fishes.

4. "The Increased Pressure by the Water.—The pressure of the atmosphere, on the level of the sea, amounts to fifteen pounds per square inch of surface on the body of an animal; but the pressure amounts to a ton weight for every one thousand fathoms of depth.

5. "With the Sunlight, Vegetable Life ceases in the Depths of the Sea.—All deep-sea fishes are therefore carnivorous; the most voracious feeding frequently on their own offspring, and the toothless kinds being nourished by the animalcules which live on the bottom, or which, 'like a constant rain,' settle down from the upper strata toward the bottom of the sea.

6. "The Perfect Quiet of the Water at Great Depths.—The agitation of the water, caused by the disturbances of the air, does not extend beyond the depth of a few fathoms; below this surface-stratum there is no other movement except the quiet flow of ocean-currents, and near the bottom of the deep sea the water is probably in a state of almost entire quiescence."

Now, the effect of these conditions on some part or parts of their structure is such that all deep-sea fishes are easily recognizable, without positive evidence of their having been caught at a great depth, and in many of them the most striking characteristics relate to the pressure of the water they inhabit. Their bones and muscles are comparatively feebly developed; the former "have a fibrous, fissured, and cavernous texture, are light, with scarcely any calcareous matter, so that the point of a needle will readily penetrate them without breaking." They are loosely attached to each other—the vertebræ especially; and, unless carefully handled, the body will almost certainly fall to pieces. But that this is not the animal's normal condition we may be well assured. It is due simply to the absence of the pressure which keeps the whole organization compact; for, as has just been stated, most of these fishes are rapacious, and to indulge their enormous voracity they must execute rapid and powerful movements, to effect which their muscles must be as firm and their vertebræ as tautly braced as in their surface-swimming relatives. Marvelous as this is, it is far from being all that is marvelous in the structure of these dwellers in the profundities. Besides modifications of their eyes, such as are found in several other groups of animals, many of them are furnished with "more or less numerous, round, shining, mother-of-pearl-colored bodies imbedded in the skin," of which Dr. Günther says: "These so-called phosphorescent or luminous organs are either large bodies of an oval or irregularly elliptical shape placed on the head, in the vicinity of the eye, or smaller round globular bodies arranged symmetrically in series along the sides of the body and tail, especially near the abdominal profile, less frequently along the back. . . . The organs of one kind consist of an anterior, biconvex, lens-like body, which is transparent during life, simple or composed of rods; and of a posterior chamber, which is filled with a transparent fluid, and coated with a dark membrane composed of hexagonal cells or of rods arranged as in a retina. . . . In the other kind the organ shows throughout a simple glandular structure, but apparently without an efferent duct. Branches of the spinal nerves run to each organ, and are distributed

over the retina-like membrane or the glandular follicles. The former kind of organs are considered by some naturalists true organs of vision (accessory eyes), the function of the latter being left unexplained by them."

There can hardly be a reasonable doubt that the functions of these organs, of both kinds, have reference to the conditions of light under which the animals live, but further than that judgment concerning them must be suspended. Dr. Günther briefly states three hypotheses that have been broached as possible: 1. That both kinds are "accessory eyes," to which the objection is offered that several fish having well-developed and even large eyes, perfectly adapted for seeing in the dark, are endowed with them, while in other deep-sea fishes, without external eyes, they are absent. 2. That only the organs with a lenticular body and a retina-like membrane behind it are visual, but that the glandular organs are phosphorescent; and more may be said for this view than for any other, since the glandular organs are certainly luminous. 3. That all the organs are producers of light, in which case it must proceed from the inner cavity and be emitted through the lens-like body as through a bull's-eye lantern. It will be hard to decide which of these suppositions is the right one, for it seems impossible to reproduce in the animals and their environment on the surface the conditions of an uninterrupted deep-sea life. [This subject was fully discussed by Dr. Ernest Krause in the last number of "The Popular Science Monthly."]

The deep-sea fishes display few colors. Their bodies are generally black or silvery, with a most brilliant sheen, which is preserved even after years of immersion in spirits. A few are "picked out" with bright scarlet, either on the fin-rays or the filaments attached to them. These filaments, it may be said, are eminently characteristic of fishes that inhabit still water, and the fact that many of the deep-sea forms are adorned with them perfectly accords with the belief that the abysmal regions are quiet.

Another remarkable property of some of these creatures is the possession of a stomach so capable of distention that it can hold a prey of twice or thrice the bulk of its destroyer. Dr. Günther gives figures of two or three fish with distended stomachs; and Mr. Johnson, his associate in this investigation, writes of a specimen which he procured at Madeira:

"The man from whom I obtained it stated that he had a fish with two heads, two mouths, four eyes, and a tail growing out of the middle of the back, which had astonished the whole market; and the fishermen, one and all, declared they had never met with anything like it before. At first sight it really did appear to be the monster described; but a short examination brought to light the fact that one fish had been swallowed by another, and that the features of the former were seen through the extensible skin of the latter. On extracting the fish that

had been swallowed, it proved . . . to have a diameter several times exceeding that of its enemy, whose stomach it had distended to an unnatural and painful degree." The action performed by the fish in these cases is not, however, a real swallowing, but more like the similar process executed by serpents.

The interest of Dr. Günther's book does not end with the account of deep-sea fishes, but the chapters devoted to that subject and to classification illustrate the most striking discoveries that have been recently made in ichthyology. Among the curiosities of fish-life that please and amuse as well as instruct, is the story of the fighting-fish of Siam, which, on seeing another of its species, or even its own image, in a mirror, becomes suddenly excited, and of which, though it is dull in hue at other times, "the raised fins and the whole body shine with metallic colors of dazzling beauty, while the projected gill-membrane, waving like a black frill round the throat, adds something of grotesqueness to the general appearance." The Siamese are infatuated with the combats of these fishes, staking on the results considerable sums, and sometimes their persons and families, while the license to exhibit fish-fights is farmed, and brings in no small revenue to the royal treasury.

The peculiarity of the flounders, and other flat fishes, by which the eyes, normally situated in the young, move around as the animal grows, until they are both on the same side of the body, is well known, but the manner in which the transposition is effected is still in question. There is, moreover, no end to the wonders to be found in fishes' eyes. Those of the genus *Anableps*, known in Demerara as "four eyes," have the iris horizontally divided by a black band, which almost justifies their name; and as these fishes frequently swim with the head half out of the water, it is presumed that the upper and lower portions of the cornea are adapted for the different density of the media in which they are respectively used. The "star-gazers" (*Uranoscopus*), and others, have eyes that can be raised or lowered at will; but the most remarkable instance of mobility in these organs seems to exist in certain gobies of the genus *Periophthalmus* and its ally *Boleophthalmus*, which might be called "oglers," as they have the power of thrusting their eyeballs far out of the socket, and turning them as freely as a chameleon rolls his. These fishes are also remarkable for another faculty, toward which their versatile eyes must contribute not a little. At low water they remain on the muddy flats, and hunt for their prey, which consists of small crustaceans and other marine animals, making rapid leaps by the aid of their fins and tails, which are strong; and when their eyes are retracted they are protected by a membranous lid.

Then the fishes that travel over land, the flying-fishes, with the controversy as to whether they really fly or only seem to (with Dr. Günther denying the reality of the flight, and others affirming it from their personal observations), and the fish that build nests, like the

stickleback, and the fishing-frog, or angler, and the salmons and the cod, and the herring, afford inviting objects of curious observation, or scientific and economical study or speculation, concerning the later results of which we have kept the readers of "The Popular Science Monthly" informed. The last fish we notice is the eel, the manner of the reproduction of which is yet a puzzle to naturalists. Dr. Günther says of it:

"Their mode of propagation is still unknown. So much only is certain, that they do not spawn in fresh water, that many full-grown individuals, but not all, descend rivers during the winter months, and that some of them, at least, must spawn in brackish water or in deep water in the sea; for in the course of the summer young individuals, from three to five inches long, ascend rivers in incredible numbers, overcoming all obstacles, ascending vertical walls or flood-gates, entering every larger or smaller tributary, and making their way even over *terra firma* to waters shut off from all communication with rivers. Such immigrations have long been known by the name of 'eel-fairs.' The majority of the eels which migrate to the sea appear to return to fresh water, but not in a body, but irregularly, and throughout the warmer part of the year. No naturalist has ever observed these fishes in the act of spawning, or found mature ova; and the organs of reproduction of individuals caught in fresh water are so little developed, and so much alike, that the female organ can be distinguished from the male only with the aid of a microscope."

THE DEVELOPMENT OF CITIES.

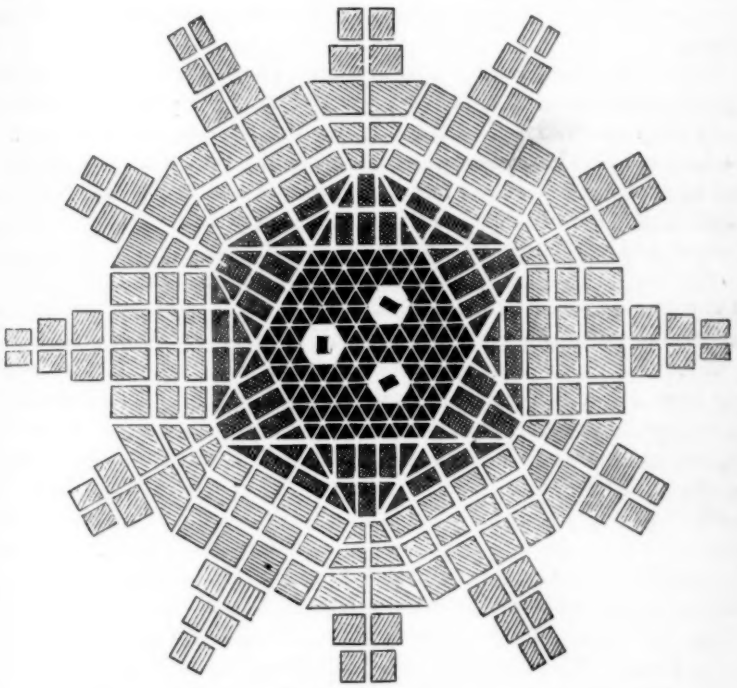
By M. BADOUREAU.

THE rectangular system of laying out streets has the advantage of extreme simplicity, and lends itself to a convenient adjustment of the interior of the houses of a city; but it is monotonous in the extreme, and makes communication between one quarter of the town and another very inconvenient; for the passenger is compelled to go along the two sides of a triangle to accomplish the distance represented by its hypotenuse. We have endeavored to solve the problem of the best way of arranging the streets of cities by mathematical calculations, but have found the task one leading to geometrical complications. We recommend the study to geometricians as an interesting one, and content ourselves here with stating the conclusions we have reached. We have examined the question in the two forms: By what law can we arrange the streets so as to lose the least possible amount of space, and still have the greatest possible length of roads; and, given a surface of which the shape and area are known, and the law of

the division of the population having been ascertained, how shall we lay out the roads so as to make the different lines of communication, particularly the most frequented ones, as short as possible? Four plans ordinarily present themselves under which the ground selected for our city to be built on may be laid out: the square, hexagonal, octagonal, and circular. Of these, the hexagonal type seems, according to our mathematical calculations, the one which gives the greatest length of streets and the greatest amount of habitable surface, with the smallest consumption of space. As a rule, for cities the population of which is homogeneous, the octagonal and hexagonal plans are much preferable to the square in respect both to the utilization of the surface and the facility of communications. Unfortunately, both plans are liable to the objection that they give house-lots having acute angles of sixty degrees in the hexagonal, and of forty-five degrees in the octagonal plan. Practically the population finds it convenient to bear toward the center of the city, and, the more it bears that way, the more it is to its interest to do so. Consequently, the density of the population diminishes from the center toward the circumference. Under such conditions, the circular plan is very satisfactory. It has in effect the double advantage of furnishing direct roads to the center of the town, and of accommodating itself to giving to the houses in the outlying quarters the greater amount of space they require. For the center of cities, where the population is compact and homogeneous, where land is dear and communication is needed in every direction alike, the hexagonal plan, with the reservation of a few places for public monuments, is most convenient. This central part might be surrounded by a boulevard, beyond which the circular type might be adopted with modifications so as to avoid curved streets. The principal streets of each suburb might be directed toward the center of the city, and each suburb might in itself be laid out more or less according to the rectangular type. The transverse streets would, however, spread farther apart as the distance from the center became greater; and main diagonal streets might be arranged to cross the whole city, with few or only slight deviations. Beyond the suburbs, the principal radial streets might be continued for a considerable distance farther, but the transverse streets would nearly disappear. The accompanying design has been drawn according to these principles. It is worthy of remark that the sketch is more like the European cities that have grown up by progressive additions than the American cities which have been built on a so-called rational plan.

So far we have considered the question from an exclusively geometrical point of view. We may continue our study by referring to the influences which geographical, meteorological, commercial, and political conditions have had in the laying out of cities. Certain directions in the ways of communication are often imposed by the topographical situation; as, for example, when the town is crossed by a river or a

highway. Some cities are free to extend over the plain in any direction, while others are restricted to narrow valleys, or to islands of which they cover the whole. The city of Cadiz, confined upon an island, has very high houses, with terraces and lookouts, the object being to reach a height where the air will be healthy and the rain-water pure. St. Malo is built much after the same fashion, and the



streets in both cities are very narrow. Every one knows that the principal highways in Venice are canals, and that the several islands are traversed by prodigiously narrow and crooked streets. On the other hand, the cities of Hungary extend over considerable spaces and are thinly populated. The city of Maria Theresa, or Szabadka, for instance, according to E. Reclus, covers a space of eight hundred and ninety-six square kilometres, and is really nothing but a province cut up by regular avenues, by the side of which houses stand at intervals —an oasis of stone in the immense plain.

We may remark, with respect to the bearing of climate, that narrow and crooked streets protect the inhabitants against heat and against cold, but they foster the accumulation of miasms and prevent the circulation of air. Cities tend to expand on the side from which the prevailing winds come. It is the most pleasant side, because it is free from the unhealthy emanations of the town.

In considering the economical side, account must be taken of the density of the population and the frequency of communications. It is important that the principal centers be connected by wide, direct, and easy roads following the course of the most usual commercial currents. Theoretically, the width of each street should be proportionate to the traffic upon it.

Historical considerations may sometimes rule, for due force must be allowed to existing conditions in the construction of each new street.

Sometimes cities are built so fast that we might say they are made up of sections constructed after a plan framed in advance. In such cases they generally present a regular disposition. Such a town is Carlsruhe, in Baden, where the avenues converge toward the Château, and of such character are most American cities. Generally, however, in old Europe, cities develop themselves slowly, and the laying out of their streets has been influenced by the circumstances in their history.

Open cities generally expand gradually by the building of houses along the roads toward neighboring towns. They thus take a kind of radiated or palmate form, quite favorable to facility of communication.

Fortified cities are developed in an intermittent way. After having been for a long time smothered within their walls, they end by breaking the barriers down and uniting with their suburbs; constructing elegant boulevards in the places formerly occupied by their fortifications. The city of Paris bears the marks of several changes of this kind. Generally the extension takes place alike in all directions, and the towns that have undergone such metamorphoses present a succession of concentric zones separated by circular boulevards. The central nucleus generally offers a close agglomeration of high houses parted by narrow, crooked, and everywhere crowded streets. Here public and private business is transacted, and the centers of trade and amusement, the public offices, and the churches, are established. Through this part also lie the usual ways of passage from one suburb to another. Most frequently the old town is traversed by a grand artery, the history of which goes back to the origin of the place, and which is usually busy with trade and much crowded. The population of the suburbs is generally less dense than that of the city proper; and the streets are wider, and the houses farther apart. The inhabitants of the suburbs are in the habit of going frequently to the center of the city, because it is the most populous part, and because the roads to the other suburbs lie through it. The principal streets of the suburbs also converge toward the center.

All the characteristics we have sketched may be found in the city of Vienna, where the ancient city, still called *die Stadt*—"the City," rests on a branch of the Danube in the north, and on the Wien in the southwest. The cathedral, situated in the center of the town, St. Stephen's Place, and the Graben, are still the points toward which the

Viennese and strangers are most in the habit of resorting; thence bear toward the north and toward the south, the Kärntnerstrasse and the Porte Rouge Street, so as to form a grand artery traversing the whole of the ancient city. One of the finest boulevards in the world has been built on the site of the fortifications that surrounded the place in the east, south, and west; and beyond this "Ring," as well as on the north side of the branch of the Danube, vast suburbs, regularly laid out, extend in every direction, enlarging tenfold the surface of the city.

Sometimes circumstances prevent the development being equal in every direction. The city of Antwerp, resting on the Scheldt, presents, with the suburbs that have recently been annexed to it, a semicircular form. Calais has only one suburb, much more populous, it is true, than the city itself; and the fortifications which separate the town and its suburb are to be razed and replaced by boulevards. Dismantling is not the only agency by which the aspect of cities may be suddenly modified. A great fire, for example, destroyed the central part of the city of Rennes in 1720, after which a new town, with high houses, wide, straightened, and rectangular streets, and handsome squares, was built in place of the burned one. A few old quarters, which the fire had spared, formed an ugly enough inclosure for this new town, which still partly exists. At the same time the suburbs have stretched out along all the principal roads, and a few new quarters have been built in the healthiest part of the suburban zone. At other times the hand of man destroys entire quarters, to reconstruct them in a more convenient and more hygienic manner. In such cases the worst quarters are the first to suffer transformation, and become in their turn the most elegant ones. The example set in Paris, under the administration of M. Haussmann, has been extensively followed in other cities in France and abroad. The construction of new basins in seaports also frequently leads to radical modifications of the aspect of the towns and in the grouping of their streets. We are evidently very far from exhausting the questions that grow out of the subject; but we hope we have succeeded in showing how complex and interesting they are, and how imperfect is the plan of those cities that are laid out in a net-work of rectangular streets.—*Translated from the Revue Scientifique.*

SKETCH OF PROFESSOR S. S. HALDEMAN.

THE career of Professor Haldeman illustrates how a student, who has his heart in his work, may excel as a specialist in more than one branch of science; and shows how the enthusiastic investigator, seeking light from all sides on the point he has under investigation,

may be led by the natural course of his work from one branch to another, which at first view seems quite distinct from it. Professor Haldeman was in his early youth a collector of living objects around his father's estate, and thus laid the foundations, in his recreations, for the eminence he afterward reached as a naturalist. Then, having turned his attention to ethnology, he was drawn to the study of languages and philology, and became one of the most distinguished American scholars and authorities in those branches. Next, he became interested in archæology, and contributed to that subject in his papers before the American Association of 1880, the last literary labors of his life. His success in all of these branches appears to have been owing to the adaptation of his natural tastes, and these to have been developed from inherited peculiarities.

Samuel Stehman Haldeman was born, August 12, 1812, at Locust Grove, on the Susquehanna River, twenty miles below Harrisburg, Pennsylvania. His family were of Swiss descent, had possessed the extensive estate which was their home for several generations, and occupied a considerable social position. His great-grandfather was a member of a local Committee of Public Safety in Revolutionary times; his great-uncle was the first Governor-General of Canada under British rule; his grandfather was a member of the General Assembly of the State in 1795. A niece of his great-grandfather and great-uncle, Mrs. Marcet, born Jane Haldimand, was a celebrated scientific writer, distinguished as the first who attempted to popularize science, by the publication of her "Conversations" on chemistry, natural philosophy, botany, mineralogy, language, and political economy. Professor Haldeman derived his middle name from the maiden name of his mother, Frances Stehman, who was an accomplished musician, and transmitted to him that correct ear for the notation of sound that made him in after-life so accomplished a phoneticist. His father was a man of literary tastes, and warmly encouraged the son's aspirations in a direction congenial to his own. Young Haldeman's education, till he was thirteen years old, was carried on in the local schools and his father's library. No little of it was gained on the farm, where he made the collections of specimens in natural history, which he was taught by a Methodist minister how to prepare, and of aboriginal stones and implements, which constituted his first museum, in the loft of the family carriage-house; and where he gathered shells, he says, on the banks of the Susquehanna long before he knew the meaning of genus and species.

When five years old he was a fellow-scholar with Daniel Engle, who could not speak English, but could spell in German, and sat with him. Young Haldeman soon discovered that his companion could spell in another language, and engaged him to bring his German spelling-book to the school, so that he could learn to do the same. The book was brought, and carefully hidden, to be studied in secret.

The teacher found the boys out, and forbade their studying German during school-hours, but allowed them to do so at recess and noon, when he also took a part in the exercise.

In 1826 Haldeman was taken to Harrisburg, to the classical school of Dr. John Miller Keagy, a "great teacher," who, besides the classical languages, "knew Hebrew, German, and French. He had a taste for the natural sciences, and in the absence of class-books he taught orally in an excellent conversational style." He remained two years at this school, and was then sent to Dickinson College, where his scientific tastes were encouraged by Professor Rogers, afterward State geologist. The stereotyped course of study of the college was not consonant with his own views of how his faculties should be trained, and he left the institution after two years, to take the superintendence of his own studies. He became ostensibly engaged with his father in conducting a saw-mill, but spent much of his time in field-studies, and with his books, concerning which he wrote at the time: "I developed a taste for rainy weather and impassable roads; then I could remain undisturbed in the perusal of my books, a supply of which I kept in a back office, where I retired as soon as the sky looked threatening." In 1833–'34 he attended the lectures of the medical department of the University of Pennsylvania, but without any design of becoming a physician. In 1835 he was married to Miss Mary A. Hough. Shortly afterward he removed to Chickies, Pennsylvania, to the house which he occupied till the end of his life, and became a silent partner in the iron business conducted by his brothers, Dr. Edwin and Paris Haldeman. In connection with this business he wrote two papers for "Silliman's Journal," on "Smelting Iron with Anthracite Coal," and edited, in 1855, a revision of Taylor's "Statistics of Coal." "In his residence at Chickies," says Dr. D. G. Brinton, in his memorial before the American Philosophical Society, "books and cabinets accumulated under his laborious hands, only to be scattered again and give place to others when his insatiable appetite for knowledge led him into new fields of investigation. For forty-five years he spent most of his time in his library, where, in his vigorous manhood, he worked sixteen hours a day. For, though he accepted several professorships, and delivered a number of courses of lectures, he did so with reluctance, preferring to be master of his time, and to spend it in the quiet of home."

He received from Professor Rogers an appointment as assistant on the Geological Survey of New Jersey in 1836, and of Pennsylvania in 1837. His field of work in Pennsylvania embraced that part of the State lying between the Blue Mountain and the South Mountain, the most important division, geologically, in the State. While engaged upon it he discovered the fossil plant, *Scolithus linearis*, the most ancient organic remains found in Pennsylvania, on which he published a monograph in 1840. During this period he also recorded the observations, real discoveries, that the peregrine falcon makes its nest in

rocks, as in Europe, and not in trees, as Wilson and others had supposed; and that the American eagle is a fishing-eagle, robbing fish-hawks when he can, diving himself after fish when he has to. He also discovered and described a new species of trilobite in Pennsylvania, which Professor Hall named after him.

Professor Haldeman's first publication was made in 1835, the year of his marriage, and was a paper in the "Lancaster Journal," exposing the falsity of the celebrated "Moon Hoax," published by Richard Adams Locke in the New York "Sun." He also published, in connection with his labors as a naturalist, a work on the "Fresh-Water Univalve Mollusca of the United States," in nine parts, 1840 to 1866; three numbers of a series of "Zoölogical Contributions"; "Outlines of the Zoölogy of Pennsylvania"; a sketch of the natural history and geology of Lancaster County, Pennsylvania; a monograph on the genus *Leptoxis* for a French work; an article on the "Zoölogy of the Invertebrate Animals," for the American edition of the "Iconographic Encyclopædia"; and seventy-three papers which Professor Agassiz has enumerated as having appeared in the scientific and philosophical journals and "Transactions" of the United States up to 1852.

"Dr. Haldeman," says Mr. C. H. Hart, "very early took a deep interest in the languages of the North American Indians, and, as an aid to the study of ethnology, he now devoted his attention to the study of language in general; and doubtless it will be as a learned and accurate philologist that his labors will be most remembered. His investigations in this most interesting study were not directed so much to the origin and source of language as to rendering it facile of acquirement and expression—his specialty being the notation of the elementary sounds uttered by the human voice in speech; thus reaching the form of language, which is merely the peculiar method of uniting thought with sound." The first result of these labors in this department was the paper entitled "Some Points in Linguistic Ethnology, with Illustrations chiefly from the Aboriginal Languages of North America," which was published in the "Proceedings of the American Academy of Arts and Sciences," in October, 1849. A work on the "Elements of Latin Pronunciation," which was published in 1851, and was warmly received, was an indirect result of studies which he pursued with the object of finding a way to adapt the Latin alphabet, while adhering strictly to its Latin signification, to the representation of the sounds of the native Indian languages. From this he was led on to pure linguistic studies, the fruits of which appeared in his "Investigation of the Power of the Greek β, by Means of Phonetic Laws" (1853), in a monograph "On the Relations between Chinese and the Indo-European Languages" (1856), and in his report to the American Association for the Advancement of Science "On the Present State of our Knowledge of Linguistic Ethnology." Having delivered some lectures on the "Mechanism of Speech" before the Smith-

sonian Institution, he entered the competition for a prize of one hundred pounds offered by Sir Walter Trevelyan, President of the Phonetic Society of Great Britain, for the best essay "On a Reform in the Spelling of the English Language"; to contain among other features "an analysis of the system of articulate sounds, an exposition of those occurring in English, and an alphabetic notation, in which as few new types as possible should be admitted." The result of this effort was a work on "Analytic Orthography," which, even before it had been revised in accordance with the suggestions of the donor of the prize, was preferred to the essays of seventeen competitors, all learned European philologists, and which was published in 1860. Five years afterward appeared a work on "Affixes: in their Origin and Application exhibiting the Etymologic Structure of English Words," which was pronounced, by a writer in the "Contemporary Review," "a collection more rational, complete, and exhaustive of the component parts of our language than we have had any good right to hope for within the present century."

Professor Haldeman was one of the founders of the American Philological Association, and was its first vice-president 1874–'76, and its president 1876–'77. He contributed many papers to its "Transactions," the first of which, on the "German Vernacular of Pennsylvania," was afterward extended, under the light of new studies, at the request of the Philological Society of London, into "Pennsylvania Dutch; a Dialect of South German, with an Impression of English," which was published in 1872. His last published philological work, "Outlines of Etymology," had in view the teaching of this as other sciences are taught, and appeared in 1877.

To this department of Professor Haldeman's activity belong his labors in behalf of reform in the spelling of the English language, in connection with which he presided at the International Convention on the subject held in Philadelphia in July, 1876, when the Spelling Reform Association was organized, and he was made one of the vice-presidents. His address to the American Philological Association at the close of his presidency in 1877 was devoted mainly to this reform.

Of his attainments in philology, Professor March says: "Professor Haldeman was in early life and by his mental constitution a scientist, and he took hold of the facts of speech in that spirit. He had a delicate ear and flexible organs of speech, and could pronounce with ease the most unutterable scientific vocables. His scientific habit enabled him to watch and describe the movements of the organs in producing all sorts of sounds, and to give the physical processes or causes of the changes in the sounds of words from age to age. He devoted much study to these subjects, seeking living speakers of every nation and tribe, and imitating and recording their peculiarities. He applied his knowledge of the laws of letter-change to etymology—chiefly, so far

as I know, to the derivation of English words and affixes. His text-books on that subject are full of ingenious observation and careful scientific deduction. He was also a great reader of old English books in their early editions, and he treasured in his memory the curiosities of spelling and pronunciation, the rhymes and puns and the like which he found there. He busied himself also with the Pennsylvania Dutch, as it is called, and traced it to its sources in Europe. He read largely the German works on the science of language, but he was an independent observer, and more likely to be biased by his critical temper than by absorption in any systems."

Professor Haldeman was actively interested in education, and occupied professorial chairs during a large part of his life. He was chosen Professor of Zoölogy in the Franklin Institute in 1842, and afterward filled the positions of chemist and geologist to the Pennsylvania State Agricultural Society in 1852; Professor of Natural History in the University of Pennsylvania, 1850 to 1853; professor in the chair of the same name in Delaware College, Newark, 1855 to 1858; and Professor of Comparative Philology in the University of Pennsylvania from 1869 till his death. He regularly attended the meetings of the Pennsylvania State Teachers' Association. Professor Haldeman had in great part been induced to change his studies from zoölogy mainly to linguistics by the failing condition of his eye-sight; in a similar manner an order to take exercise for his health became the occasion of his engaging in the study of archæology in 1875. He proceeded to carry out an intention he had long entertained of digging for aboriginal relics in the Chickies Rock retreat, a shallow cave on his own property. Here he obtained the interesting collection which he presented to the American Philosophical Society, and which he described in a monograph "On the Contents of a Rock Retreat in Southeastern Pennsylvania," published by the society since his death, with fifteen large quarto plates. He also published archæological papers in the "Smithsonian Report" for 1877, in the "American Antiquarian" and "American Naturalist," and through the American Association.

He was a prolific and successful writer on a curious variety of subjects, some of which appear incongruous with each other. The list of his scientific publications prepared by his daughter, Mrs. Eliza Figgelmery, includes ten titles in conchology, twenty-three in entomology, two on arachnidæ, five on crustacea, six on annelides and worms, seven in geology and chemistry, thirty-three in philology, seven in archæology, and twenty-nine miscellaneous publications. Outside of the immediate circle of subjects with which his name is most prominently associated, he published one or two works of literary criticism, an essay on the "Tours of a Chess-Knight," showing how the knight can pass over the whole chess-board, touching each square but once; a collection of "Rhymes of the Poets," by Felix Ago, containing specimens of false rhymes from one hundred and fourteen prominent writers;

and two mock-heroic poems. He was a contributor to Johnson's "Cyclopædia" and an associate editor of the department of comparative philology and linguistics in it; and he left behind him in manuscript two complete philological works; one on "Word-Building," the other on "English Prosody." The diversity of occupation of which this varied bibliography affords evidence was in part a matter of principle with him, for, says Dr. Brinton, "it was his taste and apparently also his theory that a student should not be a specialist, but should devote his mind to different branches, thus securing wider knowledge"; and he once said to Professor Barber, "I never pursue one branch of science more than ten years, but lay it aside and go into new fields." That he was able to acquit himself creditably in everything he undertook, we have the word of Agassiz, who said of him, "That man Haldeman has an idea behind every word he utters." Professor Le Conte has said that "next to his valuable contributions in philology, the most important work of Professor Haldeman was in the direction of descriptive natural history. He was well versed in several branches of zoölogy, and notably in conchology and entomology; in both studies he perceived latent possibilities of future philosophical development which the then imperfect observations rendered impossible to do more than dimly outline. . . . While his contributions in the two branches of zoölogy above mentioned have contributed to their advance in this country, what are to be especially admired are the zeal, the honesty of expression, and the unselfishness with which he did everything he believed to be right, or to be his duty as the occasion dictated. . . . At all times he was an industrious and intelligent laborer, a warm and sympathetic friend, and a thorough hater of pretense and empiricism."

Professor Haldeman was born of Protestant parents, but, not satisfied with the theology that was preached around him, made a study of the evidences of Christianity for himself, and ended by uniting with the Roman Catholic Church, in whose faith he died.

His death took place suddenly on September 15, 1880, a few days after his return from the Boston meeting of the American Association. The immediate cause was heart-disease, following a period of considerable fatigue.

ENTERTAINING VARIETIES.

—— *Charles Darwin* paid a splendid compliment to John Fiske in a letter he wrote him after reading the "Cosmic Philosophy." This is part of what he said: "You must allow me to thank you for the very great interest with which I have at last slowly read the whole of your work. I have long wished to read something about the views of the many great men whose doctrines you give. I never in my life read so lucid an expositor (and therefore thinker) as you are; and I think that I understand nearly the whole, though perhaps less clearly about cosmic theism and causation than other parts. It is hopeless to attempt out of so much to specify what has interested me most, and probably you would not care to hear. It pleased me to find that here and there I had arrived, from my own crude thoughts, at some of the same conclusions with you, though I could seldom or never have given my reasons for such conclusions." It was but natural that Mr. Fiske should feel that he owed something to the memory of his departed friend for this beautiful tribute to his own labors, and he has well repaid it in his article upon Charles Darwin in the June "Atlantic Monthly." This paper is not only a cordial and highly appreciative eulogy of the character of the great naturalist, but it is probably the most "lucid exposition" that has yet been given of the special doctrines that will in future be associated with the eminent name of Darwin.

—— *The Word of a Khan.*—Hulaku, the grandson of the great Genghis Khan, exceeded even the first Caliphs in religious respect for the sanctity of his word, and it is said that he invariably refused to make a promise "till the possibility of fulfilling it became absolutely indubitable." In the winter of 1257 he laid siege to the city of Bagdad, and, after planting his battering-rams, demanded an unconditional surrender, with the threat that both the Caliph and his subjects would be made to repent it if the gates were not opened before night. The defenders hesitated, but on the following day the Tartars erected a lofty gallows-tree, and the frightened Caliph preferred to come to terms. The magnificence of his gifts seemed to soften the heart of the conqueror, for the ominous scaffold was removed; but, after a private consultation with his captains, Hulaku concluded that, after all, something or other must be done to redeem his word. So, after enjoying the hospitality of the Caliph for a day or two, they marched him to headquarters, and, instead of hanging him, sewed him up in a leathern bag and dragged him across-lots till "every joint and bone in his body was pounded as in a mortar"; and, instead of burning the inhabitants with their city, they brained *eight hundred thousand* of them, and flung them into the Tigris, till the river was actually choked with corpses. Andrew Crichton ("History of Arabia," vol. ii, p. 45) adds that the number of the slain did not even include the victims of the neighboring villages!

—— *Happiness.*—"Happiness," says Leibnitz, "results from the attainment of any greatly desired or greatly needed object."—"Happiness is health," says Helvetius.—"And luck," adds Diderot.—The harmonious development of our mental and physical faculties: Spurzheim.—Peace with God: Eckart.—*Nil admirari:* Horace.—Moral freedom: Campanella.—Victory: Simonides.—A cheerful disposition: Pestalozzi.—Self-approval: Fichte.—The enjoyment of

harmless pleasures and abstinence from injurious ones: Epicurus.—Self-improvement: Hobbes.—An income of five thousand pounds: Richard Porson.—Success: Bolingbroke.—The citizenship of an illustrious state: Sophocles.—Health, books, and solitude: Zimmermann.—Health, wealth, and a liberal education: D'Alembert.—Day-dreams for those who still hope; resignation and a padded easy-chair for those who know better: Schopenhauer.—Visions of glory before the battle of life; a comfortable lazaretto after the inevitable thrashing: Id.—Virtue and resignation: Seneca.—Freedom from the tyranny of kings and vices: J. J. Rousseau.—A good bank-account, a good cook, and a good digestion: Edmond About.—Fortitude in adversity, moderation in prosperity: Anaxagoras.—Peace: Buddha.

—— In an article on *English Poetry* the "Quarterly Review" declares that the historic method shows "how the mind and spirit of the English people in each age is reflected in the poetry of that age as it is nowhere else reflected"; and again, "how truly England's poetry has mirrored the historic condition of the several ages which produced it." The "Quarterly" thus illustrates its theory: "No English poet has more historic value than Chaucer, for none more faithfully reflects all the mingled influences that swayed his time. Though belonging by birth to the middle class, Chaucer's sympathies, as those of Shakespeare and of Walter Scott, were with the aristocrats. He soon became a gentleman and a courtier, and saw life from that side." This looks much as if Chaucer's poetic mirror was somewhat warped, and this is still further confirmed by what the "Quarterly" says: "Wide as was Chaucer's genial humanity, he still looked at life through the eyes of the well-to-do, even of the aristocratic class with whom he was so much associated. No one would guess from his poems that he lived in what a modern historian has called 'a time of shame and suffering, such as England had never known; when her conquests were lost, her shores insulted, her fleet sunk, her commerce destroyed, her people exhausted by the long and costly wars with France, and by the ravages of pestilence.' None would guess from his poems that his was the day when the black-death swept off half the population of England, and when the peasant revolt threatened revolution."

—— *The Age of Faith.*—The credulity of the patristic era may be inferred from the superstitions of the so-called philosophers of that age. Celsus, Lucan, and Apuleius, then hailed as morning-stars of rationalism, would now be in danger of a strait-jacket. The elder Pliny has been called the Roman Humboldt, and his "Natural History" a thesaurus of universal knowledge. The value of that treasury may be estimated by the following specimen-bricks: Among the *feræ naturæ* of Africa he mentions a *catoplus*, "an animal found only in Ethiopia. All who behold the eyes of this beast fall dead on the spot. Luckily, the creature has a heavy head, which is always weighed down to the earth. Were it not for this circumstance *it would prove the destruction of the human race.*" "The bodies of whelks and oysters," the Roman Humboldt assures us, "are increased in size and again diminished by the influence of the moon. Certain accurate (!) observers have found out that the entrails of field-mice correspond in number to the days of the moon's age." The flight of ravens, too, is influenced by the changes of the lunar phases, though their observance of certain days *may* be due to a religious sentiment. In the case of barn-yard fowls there is no room for any such doubt. They are religious birds. By way of establishing this point he thinks it sufficient to mention that chickens throw dust over their bodies in the manner observed by the augurs in the week of purification. During the fort-

night of the waning moon the actions of crows and starlings evince a sad disregard of religious duties, but "burying black briony in the four corners of a field will secure it against the ravages of the most impious bird." Need we wonder that the Kiddles of that age could credit the miracles of St. Polycarp?

—— *The Biter bitten.*—"Intellectual presence of mind," says Lavater, "favors the practice of dissimulation, as well as the art of repartee." This latter gift seems to be a characteristic talent of the Semitic race. Al-Mansour, the second Abbasside Caliph, was importuned to commute the sentence of a rebellious governor of Morocco, on the ground that the followers of the rebel revered him as a saint and a prophet. "That's no excuse," said the Caliph, "for, if he is endowed with the gift of prescience, he must have foreseen that I am going to hang him to-morrow."

During the thirteenth and fourteenth centuries the neglected fields of Northern Spain formed a humiliating contrast with the flourishing *huertas* of the Moorish provinces; yet Alfonso IV of Aragon tried to demonstrate the superiority of his countrymen from this very difference. "In our country men handle the sword and clowns the spade," he told the Moorish embassador; "my cavaliers are too proud to meddle with agriculture." "And yet sixty thousand of these hidalgos have condescended to fertilize the fields of Xeres," observed the Morisco.

But, of all biters bitten, the most astonished was, perhaps, the Jesuit Görres, who insulted meek Moses Mendelssohn by the question, "how it came that in all countries of Christendom the Hebrews were dreaded as cheats?" "No wonder," replied the philosopher, with his blandest smile, "since you have all been so amazingly cheated by *one of our people.*"

—— *American Stock-Breeding* is thus magnified by President Francis A. Walker, writing in the "Princeton Review": "The trotting horse we have created, certainly the most useful variety of the equine species, and we have improved that variety in a degree unprecedented in natural history. Two generations ago the trotting of a mile in two minutes forty seconds was so rare as to give rise to a proverbial phrase indicating something extraordinary; it is now a common occurrence. 'But a few years ago,' wrote Professor Brewer, in 1876, 'the speed of a mile in 2·30 was unheard of; now, perhaps, five or six hundred horses are known to have trotted a mile in that time.' The number is to-day, perhaps, nearer one thousand than five hundred. Steadily onward have American horse-raisers pressed the limit of mile-speed, till, within the last three seasons, the amazing figures 2·10 have been reached by one trotter and closely approached by another."

—— About 1800 we began to import, in considerable numbers, the favorite English cattle, the short-horn. The first American short-horn herd-book was published in 1846. In 1873 a sale of short-horn cattle took place in Western New York, at which a herd of 109 head were sold for a total sum of $382,000—one animal, a cow, bringing $40,600; another, a calf five months old, $27,000; both for the English market. To-day Devons and short-horns are freely exported from New York and Boston to England, to improve the native stock.

—— The Society of Dilettanti was formed one hundred and fifty years ago, by a number of gentlemen who had traveled in Italy and enjoyed its treasures of antiquity and art, for social intercourse and æsthetic improvement. Englishmen most distinguished in politics and literature have been among its members. Originally it was indispensable that a candidate for admission should have been

met in Italy by the member proposing him. This rule is said to have led on one occasion to a resolution of the members which might well astonish geographers. A candidate had been elected on the strength of his having been met at Avignon —at that time really more Italian than French in all its associations. The mistake was seen, and in order to maintain the validity of the election a special resolution was carried, that "in the opinion of this society Avignon is in Italy." It was then considered that a dangerous precedent might have been created, and forthwith a second resolution was passed, that "in the opinion of this society Avignon is the only town in France which is in Italy."

—— *Christian Liberality.*—President Arthur being on Long Island the other Sunday with some publicans and sinners, and the party being an hungered while the corn was not eared, plucked the contents of a trout-pond and did eat. Whereupon the Scribes and Pharisees are shocked at this desecration of the Sabbath-day. The "Christian Union," in an article suffused with complacency at its well-known Christian liberality, remarks: "The country can afford to have a mistaken public policy maintained through four years of misadministration better than it can afford to have a bad example of Sabbath-breaking, impiety, and vulgarity, set before the whole community by men of the first eminence."

—— *Ownership and Rental.*—Of the 3,800,000 farms, approximately, into which the cultivated area of the United States is divided, sixty, or even seventy, per cent are cultivated by their owners. In the Northern States the proportion rises to eighty per cent, or even higher. Connecticut, Maine, and Massachusetts, of the New England States, and Wisconsin, Michigan, and Minnesota, of the Northwestern States, show an excess of ninety per cent.

—— The bigotry of the orthodox Russians, like that of the conservative Spaniards, is a sort of mental disease, but there is less method and more humor in the madness of the Muscovites; a facetious answer has often propitiated the wrath of their clerical inquisitors. The Synod of Moscow once arraigned the philosopher Lermontoff on the charge of being an abettor of the Copernican heresies, especially of the "doctrine of plural worlds," and requested him to explain his paradogmas. "From the bugs in the beard of your Eminence," Lermontoff addressed the "grand metropolitan," "I infer that the beards of the worshipful coadjutors are similarly infested, and by a parity of reasoning the population of this earth inclines me to suspect a plurality of inhabited planets." They let him go.

General Skobeleff, in his memoirs of the Turkish campaign, tells an equally good story at the expense of his orthodox countrymen. When the vanguard of his cavalry approached the hamlet of Kerzanlik, in the eastern Balkan, the frightened burghers sent out a deputation of prominent citizens to implore the clemency of the conqueror. Skobeleff returned an evasive reply, and, after a private consultation with his colleagues, the spokesman of the committee repeated his appeal with the following amendment: that, rather than have their town pillaged, the citizens would agree to supply every trooper of his command with sixteen pints of *slibovitz* (plum-brandy), and consent to believe *in any number of gods not exceeding two dozen!*

CORRESPONDENCE.

VIBRATION OF ROCKS.

Messrs. Editors.

REFERRING to Dr. Garretson's communication in the February number of "The Popular Science Monthly," relating to rock-vibration in the Patapsco Valley, I would state that a like phenomenon has often been manifested at Cuyahoga Falls, Ohio, and has been the subject of much curious speculation on the part of the inhabitants of that village. It has been supposed that the vibrations were caused by the water flowing over the river-dams, but the mystery has been, why the effect should be produced at such great and irregular intervals. Sometimes the vibrations do not occur with noticeable force within intervals of less than one or more years, and yet the quantity of water flowing over the dam increases and diminishes almost continually within its maximum and minimum limits. When the rock-vibrations occur they produce an intermittent rattling of loose window-sashes and jarring of buildings. The Cuyahoga River, which runs through the village, is about fifty or sixty feet wide at the first dam. The height of the dam may be twelve feet. The back water extends about two miles, the banks being sloping and of moderate height. Below the first dam the river runs through a rapidly descending rocky gorge, there being four or five dams within a distance of about half a mile. W. F. H.

CUYAHOGA FALLS, OHIO, *February* 19, 1882.

DEFINITIONS OF MATTER AND FORCE.

Messrs. Editors.

I WRITE to ask whether the following definitions, distinguishing the three states of matter, have ever been given to the public. I have not found them in any text-book. Also, whether the test given herewith, distinguishing the two kinds of forces, has ever been formally stated in any scientific work. If not, I think it would be well that they should both appear in "The Popular Science Monthly." I submit them to your consideration: *Definitions distinguishing the three states of matter.* — A solid is matter whose cohesion is greater than gravity upon its particles. A liquid is matter whose gravity is greater than the cohesion of its particles. A gas is matter, the repellent force (or heat) of whose particles is greater than gravity and cohesion combined. *Test distinguishing the two kinds of force.*—All forces are divided into two kinds, attractive forces and motive forces, or attractions and motions, and may thus be distinguished: All motive forces can be insulated; no attractive force can be insulated. Had this test been understood in the days of Newton, it might have saved the scientific world immense experimental labor.

Respectfully,

E. H. RANDLE.

RIPLEY, TENNESSEE, *May* 2, 1882.

EDITOR'S TABLE.

SPENCER'S DESCRIPTIVE SOCIOLOGY.

THERE are many who will regret to learn that this great work has been brought to a close. It has not been carried as far as its projector originally intended, but still we can not say that it has stopped prematurely or remains merely as a fragment. On the contrary, it is substantially accomplished. It was a large enterprise, broadly conceived by Spencer twenty-five years ago, as a comprehensive basis on which to build the superstructure of sociological principles. The undertaking involved a carefully digested method of collecting and classifying all the main orders of facts which represent the constitution and characteristics of different human societies, in a form suitable for convenient reference and ready comparison; and it was on a scale that implied the co-operation of several scholars working through many years to execute it. It was inevitable that this task should be of gigantic proportions and involve enormous labor, because social generalizations, to have value, must be based upon that which is both

common and peculiar to many and diverse communities.

The enterprise was, moreover, wholly new, nothing having been previously done toward gathering the multitudinous data necessary for studying what may be called the natural history of human societies. It was also desirable that the work should at first be so effectually done that it could be made popularly available; and, in securing this object, the magnitude of the effort expended upon it by the editor and the compilers simply represented so much labor saved by the student of social questions. Its preparation was not only an elaborate process of condensation and simplification, but it involved a selection of valuable data to be of permanent use in subsequent social inductions and constructions. An incalculable amount of material had to be overhauled to find the pertinent facts. It was a winnowing of the bulky chaff of history to separate its wheat. Science applied to history gives us first of all a revaluation of its materials. The great mass of it must be left out as comparatively worthless. As Professor J. R. Seeley well remarks: "History is now a department of serious scientific investigation. We study history now in the hope of giving more precision, definiteness, and solidity to the principles of political science." And it may be added that we are beginning to study history with a view of obtaining clearer, truer, and broader ideas of the constitution and development of human society.

It is unnecessary here to expatiate on the value of Spencer's method in this undertaking, or the thoroughness of its execution. The original plan, though not technically completed, has been carried out on a comprehensive scale. Three great groups of human communities have been treated, viz.: 1. Savage and Uncivilized Societies; 2. Civilized Societies, Extinct or Decayed; and, 3. Civilized Societies, Historic and still Flourishing. Of these groups, representing communities of every type and grade, past and present, stationary and progressive, the social constitution and history of seventy-two distinct communities are systematically described.

This is done in eight large folio parts or separate treatises, in which the facts are first brought into relation by tabular arrangements, and then the authorities for all the statements are given in an appended form as extracts from the works consulted. The simplification is remarkable; and the command given over the immense details of the whole subject is something quite incredible to those unacquainted with the work.

We are therefore justified in saying that Spencer's "Descriptive Sociology" is nothing less than a cyclopædia of social data, inexhaustible in its wealth of instructive facts, lucid in method, elaborately fortified in its authorities, free from all hypothesis, and furnishing in a very accessible form the kind of knowledge most demanded by the modern student of social affairs.

It would seem that such a work ought to have been welcomed and liberally sustained by a public-spirited age. But it has been commercially a disastrous failure. The obvious reason is, that there is but very little appreciation of the need of such a work. Neither our so-called "Schools of Political Science" nor our so-called "Associations for the Promotion of Social Science" seem to have any idea of what science means in relation to social phenomena. The solitary cultivators of the science are without backing by any parties, societies, or schools, and are left to their unaided exertions. Mr. Spencer could find no publisher to take the pecuniary risk of his enterprise, and so he printed his costly cyclopædia at his own expense. He contributed his talent and his time, paid his assistants and his printer's bills, but he made a work that was not wanted and would not sell, and

he has had to take the penalty in very serious losses. With Part 8, devoted to French Sociology, he issues the following notice of the cessation of the work:

With the issue of the eighth part, herewith, the publication of the "Descriptive Sociology" will be closed.

The collecting, classifying, and abstracting of the materials contained in the parts now completed was commenced in 1867; and the work, carried on at first by one compiler, subsequently by two, and for some years by three, has continued down to the present time.

On going through his accounts, Mr. Spencer finds that during the fourteen years which have elapsed since the undertaking was commenced, the payments to compilers, added to the costs of printing, etc., have amounted to £4,425 15*s.* 7*d.*, while up to the present time the returns (including those from America) have been £1,054 12*s.* 1*d.*—returns which, when they have been increased by the amount derived from the first sales of the part now issued, will leave a deficit of about £3,250.

Even had there been shown considerable appreciation of the work, it would still have been out of the question to continue it in face of the fact that, after the small sales which immediately follow publication, the returns, so far from promising to repay expenses in course of time, do not even yield five per cent interest on the capital sunk.

Should the day ever come when the love for the personalities of history is less and the desire for its instructive facts greater, those who occupy themselves in picking out the gold from the dross will, perhaps, be able to publish their results without inflicting on themselves losses too grievous to be borne—nay, may possibly receive some thanks for their pains.

The personality of this announcement makes some corrections here appropriate. It has been often said that the profits of Mr. Spencer's American reprints have been greater than those of the original English publications. This is a mistake. Some of his books sold better in this country at first, but the English sales have had a steady increase, so that the income from them has been greater than from the American editions. In regard to the "Descriptive Sociology," although encouraged by his American friends to expect fair returns from it here, the sales have been so small that the publishers declined to reproduce it after the third number, and the work has been kept in stock by the help of others and by advances from Mr. Spencer himself. The appearance of the above notice of discontinuance has, moreover, been the occasion of no little misrepresentation, both in England and in this country. In England it was rumored that Mr. Spencer's losses from publication have been so great as to compel him to go to America to recruit his means by lecturing; and in this country the newspapers have intimated that the failure of his "French Sociology" has brought him to actual want. These statements are wholly groundless. Mr. Spencer has never for a moment entertained the idea of lecturing here, although offered very liberal terms; and, while he is not a rich man, he is by no means in straitened circumstances. He could, of course, ill afford to lose sixteen thousand dollars, besides many years of labor, on a single publication, but it has certainly not made him a bankrupt.

It must be added that Mr. Spencer has never accepted a farthing from any source contributed for his private or personal benefit. When his "System of Philosophy," which was not self-sustaining, was threatened with suspension, some funds were sent him from this country to meet the expenses of its continuance, but they were accepted solely as a public trust, and to be applied to an object recognized by all as of a purely public nature.

ELECTRIC STORAGE-BATTERIES.

Since the first announcement of M. Faure's improvement of the Planté secondary battery, speculation has been rife as to the great number and kinds of uses to which such batteries could be applied; and, while much of it has been only sober prediction, some of it has been altogether fanciful. The re-

cent arrival of the steamship Labrador with a number of these batteries on board, which had been successfully used during the passage in electric illumination, has revived both the interest and the speculations about them in this country, so that a few words on their possibilities, and what has been so far accomplished, may be here appropriate. It is hardly necessary to say anything regarding the construction of the Faure cell, as it was fully described in the August number of the "Monthly" of last year, and has since received much attention in the technical papers and by the daily press.

That a thoroughly commercial storage-battery has a wide field of usefulness before it there can be no question. Of the many uses to which it could be applied, one of the most important, perhaps, is as an element in a system of electric distribution for both light and power purposes. With a storage-battery in each house, a smaller electric producing plant in continuous operation could take the place of the larger one required without it, and distribution could be readily accomplished with one set of mains, as, by simply connecting groups of battery-cells in the proper way, arc and incandescent lamps, as well as various pieces of machinery, could be run quite independently of each other.

The power that such a battery confers of utilizing the results of work performed at other times and places makes it peculiarly well adapted for use in isolated electric plant, such as would be suitable for suburban and country houses. Wind and water power are both suitable for charging the battery, but neither of them would commonly be available as direct agents in maintaining a current. It is not at all impossible that we may yet see the farmers using the power of the wind, which costs nothing beyond interest on investment in a mill and repairs, to light their houses, and obtain all the power necessary for many of the operations of the farm.

Such batteries would also have a not unimportant use in the propulsion of cars on street and suburban railways, and it is quite within the bounds of reasonable expectation to think that they could in a good many cases displace steam with advantage on ordinary railways. The conditions requisite to render this feasible are simply good water-power facilities at sufficiently frequent intervals along the line, or such a proximity to coal-mines that the electricity for the charging can be generated at the pit, and coal transportation, therefore, dispensed with. The great advantages of a method of railway propulsion which would dispense with the fire, steam, and smoke of the locomotive, are too obvious to need specifying. Many other applications of these batteries might be named, and the sphere of their utility will doubtless constantly enlarge with the progress of industry.

In order, however, for the storage-battery to take its place as an important element in the growing industrial applications of electricity, it must reach a considerably higher efficiency than it appears to have yet attained. The results obtained in the experiments on the Faure battery at the Conservatoire des Arts-et-Métiers, communicated to the French Academy of Sciences in March last, and which constitute the only trustworthy account yet given of the performance of this battery, certainly leave much to be desired. The experiments were conducted to determine—1. The mechanical labor expended in charging the battery; 2. The quantity of electricity stored up during the charge; 3. The quantity of electricity given out during the charge; and, 4. The electrical work actually effected during the discharge. They resulted in showing that the battery returned forty per cent of the total mechanical power spent in charging it, and sixty per cent of the

electrical work spent upon it. The latter result is alone to the point, as in the former the efficiency of the dynamo-machine enters as an element, as well as that of the storage-battery. On this showing the storage-battery does not seem to have reached a commercial stage, but that it will do so at no very remote time there is every warrant for believing, when we consider the large amount of attention there is now being given to the subject, and the rapidity with which electric appliances are at present passing out of the experimental into the industrial stage.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, No. XLI.

DISEASES OF MEMORY: AN ESSAY IN THE POSITIVE PSYCHOLOGY. By TH. RIBOT, author of "Heredity: its Phenomena, Laws, Causes, and Consequences," "English Psychology," etc. Translated from the French by William Huntington Smith. D. Appleton & Co. Pp. 209. Price, $1.50.

FROM both a scientific and a practical point of view this monograph is among the most interesting and valuable that have appeared in the "International Series." It is an able statement of the latest knowledge on a subject which concerns almost everybody. We can here only intimate the author's stand-point in the discussion.

Where are our thoughts when we are not thinking them? Not a ten-thousandth part of the great stock of mental acquisitions which a man possesses is ever in consciousness at any one time. And, of those which in our waking states are ever rapidly emerging and disappearing, only a very small portion are obedient to the will—they exist and are preserved independently of consciousness, and they come and go, to a large extent, by laws deeper than volition.

Where, then, is the great stock of our ideas when we are not aware of them? The common, the pre-scientific answer is, they are in the mind, which is an abstract spiritual container, of which we only know that it is an immaterial essence. This mind is made up of faculties, and memory is one of these faculties, in which the intellectual contents are stored up until called for by voluntary thought. Hamilton speculated vaguely about "mental latency," but where the mental stock is kept was always regarded as a great mystery—in fact, an insoluble mystery which there was no use in working at, because all the mind that concerns us is the mind we know about. Mind was thus bounded by consciousness, and memory, or the recall of ideas, was considered purely as a matter of volition, while this faculty in all men was looked upon as very much the same thing. Dugald Stewart, for example, says of the memory, "that original disparities among men, in this respect, are by no means so immense as they seem to be at first view, and that much is to be ascribed to different habits of attention, and to difference of selection among the various objects and events presented to their curiosity."

But it is obvious enough that nothing can be done with the problem of mental *disease* under this view; and, if we are to inquire concerning "diseases of memory," the first thing is to ascertain what we have to deal with that is capable of being diseased. This, of course, is the corporeal part of our nature, and it implies at once that memory has its organic side. It is the nervous part that registers and conserves our psychical acquisitions, and accordingly Professor Ribot begins his work by the study of nervous structures, properties, and activities, and with the consideration of memory as a biological fact. Memory implies three things: first, an impression, and therefore an organism capable of receiving impressions. The various senses bring, and the nervous centers receive and record, these impressions. The centers, moreover, recombine, reassociate, and elaborate these impressions in the most complex ways. This implies, secondly, a conserving or retaining capacity of the nerve-centers, which answers to the notion of mental storing. Then there is, thirdly, the emergence of these impressions in thought, or conscious recollection. This deliverance in consciousness is a result which we might call incidental, and depends, of course, on the prior conditions of impressibility and conserva-

tion, which are, therefore, of fundamental importance. It is estimated that there are a thousand million cells in the human brain, all bound into a living unity by four or five thousand million nerve-fibrils of amazing tenuity, and this is the grand mechanism of registering, conserving, and elaborating impressions and turning them out as groups and systems of ideas. Consciousness is merely a door through which a small part of these cerebral elaborations emerge. Mind grows as this organism grows; its capacities are at bottom organic capacities, and its diseases are breaks, failures, debilities, and degenerations of the nervous substratum of all psychical operations.

Memory is therefore not the faculty of an abstraction, but a phenomenon of nervous dynamics; and it is dependent upon the soundness, vigor, nutrition, and organic perfection of the nervous structure. It is not one thing, but our memories are innumerable. Investigating the problem from the biological point of view, our author is able to throw light on the many forms of failure to which the control of mental acquisitions is subject. He is, in fact, prepared to announce a law of the decay of memory, which explains the order in which acquirements disappear as the organ of thought declines in force by age or from various other causes. The import of the book is therefore highly practical, for in proportion as we have a correct understanding of the subject shall we be saved from the consequences of erroneous views. The subject is far enough from being cleared up, but this little book gives us more trustworthy knowledge about it than can be found in any preceding treatise upon it.

THE PRESENT RELIGIOUS CRISIS. BY AUGUSTUS BLAUVELT. G. P. Putnam's Sons. Pp. 196. Price, $1.

THIS is not at all a scientific book in the usual sense, but it raises the question in a very emphatic way that is fundamental to all science, namely, the question of liberty of thought. Whatever we may say in regard to the alleged conflict between religion and science, of one thing there can not be the slightest doubt: there is a radical and a desperate conflict between theology and liberty of thought. It is historic, and it is contemporaneous; and, if any doubt its inveteracy, let them read Mr. Blauvelt's book, which may be taken, in one of its aspects, as but a new illustration of the old experience in which religious bigotry is arrayed against free and independent inquiry.

In his preface, Mr. Blauvelt remarks: "When the author says that he was graduated from Rutgers College, at New Brunswick, New Jersey, and also from the Peter Hertzog Theological Seminary connected with the same institution, he has given a sufficient guarantee that his original instruction in divinity was of the most hyper-orthodox description. Nor does he concede that any alumnus of either Alma Mater ever went forth who was, to begin with, a more devout and implicit believer than he was in both the essentials and the non-essentials of the general orthodox theology, and notably that of the Calvinistic order.

"It is needless to assure the reader that, while he was a student at New Brunswick, the author was most securely guarded against all contamination from modern infidelity. He does not remember, for example, that in those days he ever heard so much as the mention of the name of Strauss. At the same time, he does have an indistinct recollection that, in a vague and general way, he was taught at once to dread and to abhor that modern theological monstrosity, namely, German rationalism."

It was not to be expected that an active-minded man like Mr. Blauvelt, when he began to think for himself, would be content to remain in the mental condition induced by the theological seminary. Upon assuming the function of a public religious teacher, he found the necessity of a more thorough equipment for his work than his theological instructors had provided, and he therefore entered upon the systematic study of the traditional theology, from the point of view of modern criticism. The spirit in which he engaged upon the work of biblical and religious research is thus indicated. He says that "the specific purpose with which he originally took up these investigations was to vindicate the traditional Protestant conceptions about the Bible and religion against all the assaults of the modern unbelievers. But from the very outset

he conceived the idea that, to make this vindication of any actual and permanent service to those conceptions, it must itself be actual; it must itself be scientific, it must itself be something decidedly more than merely theological. In other words, whatever inherited conceptions, about either the Bible or religion, he found he could not establish by valid evidence and by legitimate reasoning, he resolutely determined that he would never make the effort to establish either by any such distortion of evidence, or by any such illegitimate reasoning, as he had fortunately come to discover to be only too characteristic of the mediæval apologists."

Pursuing his biblical studies from this independent point of view, Mr. Blauvelt, in the spirit of the liberal scholarship of the time, was led to the formation of opinions widely differing from the orthodox traditions. The general results which he reached are given with their proofs in the first eight chapters of the little volume before us, the subjects of which are: I. The Crisis; II. Dogmatic Theology; III. The Validity of the Biblical Canon; IV. The Inspiration of the Bible; V. The Historical Character of the Gospels; VI. The Religion of the Bible; VII. Religion; VIII. The Religion of Jesus. These chapters are full of information in relation to the work of modern criticism on biblical subjects, and they afford an excellent introduction to the general inquiry, for those who wish to know how the register of theological liberality stands at present.

But the sequel of honest and fearless research proved to be in this case, what it had always been before, repression of free thought. In Chapter IX, Mr. Blauvelt gives us some examples of the treatment extended to religious men who have undertaken to inquire for themselves. He tells us that "when, in 1835, Strauss published the initial volume of his first 'Life of Jesus,' he was occupying the position of a theological instructor at Tübingen, with the most brilliant prospects before him, and beloved and honored of all. But even before the appearance of the second volume he was summarily ejected from his position. As the unparalleled commotion created by his work continued to increase, his own father turned away from him in anger; his early teachers in divinity hastened to disavow all complicity with his opinions, and 'as for the friends and companions of my studies,' says Strauss himself, 'these I had the mortification of seeing exposed to so much suspicion and annoyance for their merely rumored intimacy with me, that it became a point of conscientious duty not to expose them to still greater odium by any public memorial of our friendship."

Again, "The faculty of the Theological Seminary of St. Sulpice were once engaged in preparing their annual examinations, when a young candidate for the deaconship, who had always been noted for his great modesty and studious habits, asked leave to submit a number of questions which perplexed his mind and seemed to depress his religious spirit. Unless they were solved to his satisfaction, he could not hope to enter into holy orders. His earnestness astonished and alarmed the entire faculty. They refused at once to examine questions which to them appeared novel or subversive, and, justly fearing that a neophyte who on the threshold of the priesthood was besieged with such misgivings might become a cause of strife in the Church, they withheld their protection, and bade him depart from the consecrated place. This inquisitive and conscientious student was Joseph Ernest Renan." How he subsequently succeeded in passing with the highest honors his examination for University Professor of Philosophy; how he became Professor of Hebrew, Chaldaic, and Syriac Languages and Literature in the oldest chair of the oldest institution in the land; and how he was howled down by the clerical party so that he could not be even heard on the day of his inauguration; and how this was followed by a governmental decree suspending his course of lectures indefinitely—is now well-known matter of history.

When the volume entitled "Essays and Reviews," containing some independent theological thought, appeared in England, the authorities were besieged to prosecute the writers for heresy; and there was one petition which is said to have contained the signatures of not less than nine thousand clergymen of the Established Church, to promote this end. Bishop Colenso was subsequently

hunted down for his heresies, and Professor Robertson Smith has been very recently dismissed from the professorship of Hebrew, in the Free College of Aberdeen, for the same cause.

In further illustration of this religious hostility to independent thought, it may be stated that the author of the book before us contributed in 1873, to "Scribner's Monthly," a series of papers entitled "Modern Skepticism," which were simply a bold and forcible statement of the present drifts of liberal inquiry regarding theological matters. The periodical was widely and vehemently denounced for printing such discussions, and there were public demands made for a new editorship on penalty of the withdrawal of patronage. Dr. Holland resisted the bigoted crusade, and after a year or two another paper was forwarded to him by Mr. Blauvelt, in continuation of the argument. In reply, Dr. Holland wrote: "Your last article was received, and I have read it to-day. At the conclusion of its perusal, I find myself called upon to make the most important decision that has ever come to me for its making, since I became an editor. I must be frank with you. I believe you are right. I should like to speak your words to the world; but, if I do speak these, it will pretty certainly cost me my connection with the magazine."

So much for freedom of religious thought—American freedom of religious thought—Protestant freedom of religious thought, in the last quarter of the nineteenth century of Christianity! Of course, Mr. Blauvelt himself did not escape the penalties of applying the scientific method to theology. We do not notice the statement in his volume, but if any one will turn to "The Popular Science Monthly," for August, 1877, he will see that the reverend heretic was stripped of his office, turned out of the church, and branded as a "betrayer of his Master." It was a little too late to burn him, but is not that about as far as Christian toleration has yet "progressed"? One thing is evident: if Mr. Blauvelt had been a little more dishonest, had played fast and loose with his conscience, and had not been so anxious about the truth, he could have spent all his days in pious comfort in the bosom of the Church. Ever, and in the nature of things, repression of thought is a bid for hypocrisy.

EGYPTIAN OBELISKS. By HENRY H. GORRINGE. Published by the Author, 32 Waverley Place, New York. Pp. 187, with 41 Plates.

THE propriety of regarding as a great achievement the removal of a noble object of the oldest civilization from the place where it has rested for ages, to adorn a modern pleasure-ground among surroundings as different as possible from those among which it has stood, has been criticised by admirers of the antique. The fact that the English, French, Germans, and Italians have also taken obelisks from Egypt may show that they are not innocent, but can not excuse us if the act is, as some believe, a kind of vandalism. The criticisms can not, however, be applied justly to those who removed the obelisk in Central Park, for they did not take it from before the temple at Heliopolis, where Thothmes II set it up, but from the place to which others before them had removed it from there. The offense of removal, if it was an offense, was committed by the Romans nineteen hundred years ago; and they may have been guiltless of actual sin, for they probably found the obelisk already thrown upon the ground. Americans have been guilty of no "despoilment," or removal from among "antique surroundings"; for the most prominent surroundings which Commander Gorringe found about the obelisk at Alexandria "were a railway depot, a new apartment-house, and an Arab fort," and it would have inevitably been destroyed if he had not taken it away. In other respects, a feeling of disgust was aroused by the surroundings, and "something more than curiosity was needed to induce one to approach near enough and remain long enough to examine and appreciate it." The removal of the monument from such a situation as Commander Gorringe describes to one that is fully worthy of it, though un-Egyptian, should be considered an act deserving as much praise as the tact, ingenuity, and engineering skill that were displayed in effecting it with complete success. Readers of the present work will find abundant opportunity to admire these qualities as displayed

by Commander Gorringe, for the difficulties he had to meet, whether proceeding from the tempers of men or the stolidity of natural forces, and the means by which he overcame them, are clearly described and illustrated in the interesting and often amusing narrative that forms the first third of the volume. The account of Commander Gorringe's experiences in getting the great stone afloat and across the ocean is supplemented by descriptions of the methods, also illustrated, by which other obelisks have been transported to Paris, London, and Rome. The rest of the book is mainly historical and archæological. In it are included a review of the "Archæology of the New York Obelisk," its symbolism, translations of the inscriptions on it, and its history; a "a Record of all Egyptian Obelisks," with photographs, and translations of their inscriptions; and "notes on the ancient methods of quarrying, transporting, and erecting obelisks," including all that is known on the subject. The final chapter, arranged by Professor Persifer Frazer, describes the analyses of the materials and metals found with the obelisk, and is illustrated by polariscopic sections of rocks. The work thus combines a narrative of personal adventure and professional achievement, an exhaustive historical and archæological account of Egyptian obelisks, and the results of scientific study, in a setting in which no expense seems to have been spared to make it worthy of the subject, and to leave nothing wanting.

EXPERIMENTAL RESEARCHES INTO THE PROPERTIES AND MOTIONS OF FLUIDS, WITH THEORETICAL DEDUCTIONS THEREFROM. By W. FORD STANLEY. London: E. & F. N. Spon. 1881. Pp. 538. Price, $6.

HAVING been engaged in an experimental examination of the undulatory theory of light, from which he was obliged to desist on account of failing eye-sight, Mr. Stanley took up this subject, he tells us, from the interest awakened by the previous work, and in the hope of making clear to his own mind certain points left obscure by his previous investigations. It soon, however, appeared to him that "there was yet an immense amount of work to be done in researches in the motions of fluids before theoretical principles of the sciences of hydrodynamics and acoustics could be fixed upon mechanical principles with any great precision," and he consequently entered upon the extended investigations set forth in the present volume. Of the unsatisfactory state of much of the work in this branch of physics the author instances the case of wave-motions on water. The true procedure in this case is to determine the manner in which waves are produced on the surface of water by the action of the wind, and then, as a secondary consideration, to investigate the action of gravity in bringing the surface to equilibrium. The reverse of this order, the author asserts, is usually followed, the question being made a case of the oscillations of fluids through gravitation only, and thus begged, as you have then to assume the wave in existence, while its production is the thing to be accounted for.

The first three chapters, the author states, are speculative, and he puts them forth simply as helping to a clearer conception of the nature of a fluid. In the fourth chapter he develops a theory of rolling contact of fluids moving upon static bodies; and in the fifth and sixth chapters he offers principles of conic resistance in fluids which give simple mechanical laws for the class of motions known as vortices, eddies, and cyclones. The eighth chapter is devoted to an exposition of the "principles of motive resistance to the projection of free solids in extensive fluids," and the ninth to the "diffusion of flowing forces in fluids."

These nine chapters constitute the first section of the work, the principles established in which are applied to the elucidation of the manifold phenomena of natural currents produced by the combined effects of heat, gravitation, and the earth's rotation. In the third and closing section of his work Mr. Stanley takes up the subject of the formation of waves upon the surface of water, on which he reaches conclusions not materially different from those of M. Flangergues and Mr. Scott Russell. A fourth section upon sound-motions in fluids, which should have made a part of the present treatise, the author withholds from publication until he has opportunity to go over the subject again, with the help, which he anticipates

will be considerable, furnished by the discoveries in the telephonic transmission of sound.

MYRON HOLLEY; AND WHAT HE DID FOR LIBERTY AND TRUE RELIGION. Pp. 328. Boston: Printed for the Author, P. O. Box 109.

THE name of the author of this work is not given upon the title-page, but by turning over the leaf we get an explanation of the matter as follows:

"*Copyright secured by Elizur Wright.*"

"A copy of this book, which three leading publishers, though guaranteed against loss, have declined to publish, either with the author's name or without it, will be sent, post-paid, on the receipt of $1.50 addressed to Elizur Wright, Box 109, Boston. Or ten copies will be sent, free of freight, on the receipt of $10.

"If any profit should accrue from the sale, it will all be paid to the descendants of Myron Holley till such time as the State of New York shall have paid the just debt it owes them."

We have to thank the writer of this book for one of the most readable and instructive biographies we have ever read, and for doing justice to the character of a very rare and remarkable man. Myron Holley was born in 1779, and died in 1841. His career, which was thus ended more than forty years ago, belongs to the early part of the century, and we had heard much of his noble work and his manly characteristics, though only in a fragmentary and unsatisfying way, and had often expressed regret that there was no accessible sketch of his life. Now that we have it, it is more apparent than ever how great would have been the loss to the world if the task had remained unperformed.

The character of Mr. Holley has been brought out vividly in this volume in several relations. In the first place, he was one of the most efficient, influential, and indefatigable of the pioneers to which we owe the canal system of the State of New York. No matter how this system may be now regarded, the construction of the Erie Canal was a leading step in the progress of our Western civilization, and full of formidable difficulties from the novelty and magnitude of the project, and the state of the public mind upon the subject. One of the most interesting portions of Mr. Wright's racy and graphic book is the account he gives of the origin and growth of the canal policy, which he found it indispensable to delineate in order to bring out the full import of Mr. Holley's relation to it. He was not only a man of great energy and determination, but of admirable tact, clear judgment, and invincible integrity. He entered into the project with his whole soul, subordinated all personal interests to it, neglecting his own private affairs, under the unwise impression that, when the great public work was done, the State would do him justice. We have no room here for explanations upon this point, and must refer the reader to the pages of Mr. Wright, where it is proved that the State of New York cheated Myron Holley out of more than a hundred thousand dollars, when millions would not have repaid the State for the value of his services in carrying out the canal project.

Myron Holley's name will also be historic in connection with the progress of American ideas by his early and controlling alliance with the anti-slavery movement. He was a pioneer reformer in the days when opposition to slavery meant social execration, and when the North in all its great elements — political, ecclesiastical, collegiate, literary, and social — was on its knees to the South for every vile and venal purpose. It was in the palmy days of Northern poltroonery — when the South was told that she could have anything she wanted, and all she wanted; that she had but to name the terms on which this government might continue, and they should be conceded, and when slavery was rampant and regnant as the supreme interest of the American Republic — that Myron Holley took the lead in founding the Northern Liberty party.

To this history Mr. Wright also adds an interesting account of Holley's independent and advanced religious views, and also his ideas of domestic culture, family interests, the education of children, and the conduct of social life. In all these relations Mr. Holley was a man of great individuality, and freedom from the tyrannical restraints of mere conventionalism. He was a thoroughgoing reformer when reform was loss a vo-

cation than it has since become, and he was always marked for the reasonableness and temperateness of his views, and the ability and power with which they were presented.

Myron Holley was one of the personalities that are not to be forgotten, and we have again to thank Elizur Wright for his painstaking and generous efforts to rescue from forgetfulness a character so worthy to be remembered, and admired, and emulated.

ANNUAL REPORT OF THE CONNECTICUT AGRICULTURAL-EXPERIMENT STATION, FOR 1881. New Haven: Tuttle, Morehouse & Taylor. Pp. 122.

THE Station has been occupying borrowed quarters in the Sheffield Scientific School, which were so limited that it has been able to do little else than oversee the analysis of fertilizers. This it does gratuitously when consumers of the fertilizers, for moderate fees when proprietors and sellers, are its customers. It having become necessary to remove the Station, the director suggests it be given a situation where it can test the agricultural value of the fertilizers, and perform other experiments in practical agriculture. The act of Connecticut in establishing the Station has been responded to in other States. New Jersey has a Station in connection with the State Agricultural College at New Brunswick, which enjoys the advantage of a farm. North Carolina has lately furnished its station with excellent accommodations at public expense; and New York is organizing a station at an outlay of $20,000 a year. The report contains very full accounts of analyses and valuation of different kinds of fertilizers, and papers on fodders and feeding-stuffs, with their analyses. Of immediate and practical interest are articles on the feeding of milch-cows, at different dairies and the New Jersey Experimental Station, and on feeding with ensilage.

THE OCCULT WORLD. By A. P. SINNETT. Boston: Colby & Rich. Pp. 172. Price, $1.

THE author apparently belongs to the band of Theosophists, and asserts that the wisdom of the ancients survives as what he calls the occult philosophy, and that "it was already a system of knowledge, that had been cultivated in secret and handed down to initiates for ages, before its professors performed experiments in public to impress the popular mind in Egypt and Greece. Adepts of occultism in the present age are capable of performing similar experiments, and of exhibiting results that prove them immeasurably further advanced than modern science in a comprehension of the forces of nature." He claims, also, that these adepts have peculiar knowledge of the mental and spiritual world. He has met this science during his travels in India, and has assumed to describe in this volume his experiences of it, and the knowledge he has gained respecting it. Those who read the book with the expectation of finding anything in it to confirm the high-sounding pretensions declared at the start will be disappointed.

MARRIAGE AND PARENTAGE, AND THE SANITARY AND PHYSIOLOGICAL LAWS FOR THE PRODUCTION OF CHILDREN OF FINER HEALTH AND GREATER ABILITY. New York: M. L. Holbrook & Co. Pp. 185.

THE doctrine of this book is that "the race might be greatly improved by wiser and more sanitary marriages, and by more physiological parentage"; and the author suggests that, "if the average standard of ability of the race in intellect, in morals, and in physical power were raised one degree during each century, the results could hardly be estimated." The subject deserves discussion in a practical, common-sense manner, and receives it here.

THE NEW INFIDELITY. By AUGUSTUS RADCLIFFE GROTE. New York: G. P. Putnam's Sons. Pp. 101. Price, $1.25.

THE author has endeavored to show in this work that there is an essential difference between the religious temper of the Aryan race and the Semitic. "Our villages to-day," he says, "are Aryan settlements in their vital points, not Semitic inclosures; and it is so with our religion—at bottom it is pagan still." He has also tried to show that revealed religion is not directly attacked by the discoveries of Science. "Only Natural Religion"—which is regarded by him as the foundation of paganism—"is now assailed in her own house, by her own children, and with her own weapons. This has come to pass through the further develop-

ment of that race-tendency which seeks in nature for the proof of the existence of God. In Nature, paganism found at first many gods; and our present monotheistic idea (outside of Christianity) seems to be the result of the gradual extinction of the belief in diverse deities, by the process of discovering a single force moving the universe of matter."

AN ELEMENTARY TREATISE ON ELECTRICITY. By JAMES CLERK MAXWELL. Edited by William Garnett. Oxford: Clarendon Press. 1881. Pp. 208. Price, $1.90.

THE greater part of this work consists of articles written by the late Professor Maxwell some years before his death, with a view to their ultimate publication as an elementary text-book of the subject. Owing to the labor involved in the editing of the Cavendish papers, they were left in a very incomplete state at the time of his death, but the editor has endeavored to carry out the original purpose, by supplementing them with material taken from Professor Maxwell's larger work, "Electricity and Magnetism." The first two chapters are devoted to an experimental demonstration of the principal facts relating to electric charge considered as a quantity capable of measurement, and the third to electric work and energy. In the fourth chapter the electric field is considered, and Faraday's law of lines of induction forms the subject of the fifth. Some particular cases of electrification are taken up in the sixth chapter, electrical images in the seventh, and condensers in the eighth. The various phenomena of the current form the subject of the ninth and tenth chapters, while the methods of maintaining it are considered in the eleventh. The twelfth chapter is devoted to the measurement of electrical resistance, and the thirteenth and last to electrical resistance of substances.

THE MOTHER'S GUIDE IN THE MANAGEMENT AND FEEDING OF INFANTS. By JOHN M. KEATING, M. D. Philadelphia: Henry C. Lea's Son & Co. Pp. 118. Price, $1.

THE author has endeavored to supply a want which he believes to be daily growing, as the monthly nurses of the last generation, whose knowledge gained by experience gave them a place hardly secondary to that of the doctor, are passing away—the want of a better understanding of the requirements of a new-born babe. A necessity for artificial feeding has been developed; over-luxurious and overheated dwellings have raised the question of proper clothing; and the rapid advancement of science has taught us the value of early treatment to eradicate the tendency to inherited taint. For explaining these matters, the work considers the requirements of the infant, first from birth till the cutting of its first teeth, then during the period of dentition, and finally those of a child after its third year.

OPIUM-SMOKING IN AMERICA AND CHINA. A Study of its Prevalence and Effects, Immediate and Remote, on the Individual and the Nation. By H. H. KANE, M. D. New York: G. P. Putnam's Sons. Pp. 156. Price, $1.

"THAT opium-smoking," says the author of this work, "is a vice that imperatively demands careful study at the hands of Americans is made manifest by the fact that the practice, comparatively unknown among us six years ago, is now indulged in by some six thousand of our countrymen, male and female, whose ranks are being daily recruited; . . . that large and small towns in the West and large cities in the East abound in places where this drug is sold and smoked"; and that in some of the States it has been found necessary to enact repressive laws on the subject. Dr. Kane has made careful investigations of the methods and effects of opium-smoking, by personal experiment, by the observation of smokers in the act and afterward, by correspondence and communication with other similar observers, and by the consultation of books in which the subject is discussed, and communicates the results in this volume.

A STUDY OF THE VARIOUS SOURCES OF SUGAR: Sugar-Cane, Sorghums, Sugar-Beet, Maple, Water-Melons, etc. By LEWIS S. WARE. Philadelphia: Henry Carey Baird & Co. Pp. 66. Price, 50 cents.

THE author suggests that sugar, being the largest single article of import into the country, offers a greater field for usefulness in the investigation and introduction and development of a new industry than "any

not now here existing." He reviews all the products from which sugar is obtained or is expected to be obtained, in order to discover which one presents the most hopeful opening for enterprise. His conclusions are, that sorghum offers a difficult problem from a financial point of view; that amber-cane is a little more satisfactory, but not satisfactory enough; that the cultivation of corn-stalks for sugar would exhaust the soil; that sugar-cane can not supply the home demand; that the maple can do this no better; that the expectation of obtaining sugar from sweet-potatoes is delusive, and that of getting it from white potatoes more so. Water-melons deserve more consideration, but they are declared to be inferior to the sugar-beet; and the last is pronounced "the only possible plant which can supply the North with sugar." The question remains, whether beet-sugar can be made profitably without the artificial stimulus of protection. If not, we had better continue to raise what we can derive a profit from without artificial aid, and buy our sugar where we can get it cheapest.

VACCINATION: ARGUMENTS PRO AND CON; WITH A CHAPTER ON THE HYGIENE OF SMALL-POX. By JOSEPH F. EDWARDS, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 80. Price, 50 cents.

THE energy of the opposition manifested by a considerable number of persons against vaccination has induced the author to make his own independent study of the question. He has gathered information from all available sources and considered the arguments on both sides, as he presents them here, and has become convinced that in vaccination properly performed, and in that only, we can find immunity from small-pox. He attaches much importance to anticipating the opposition that may arise and spread in this country, as it has done in England.

FIRST AID TO THE INJURED. By PETER SHEPHERD, M. D. Revised and added to by Bowditch Morton, M. D. New York: G. P. Putnam's Sons. Pp. 88. Price, 50 cents.

A BRIEF manual intended for non-professional readers, the object of which is to furnish a few plain rules to enable any one to act in cases of injury or sudden illness, pending the arrival of professional help. The revisions and additions by the American editor have been simply such as would make the work more suitable to this country.

SIR JOHN LUBBOCK'S charming little book on "Ants and Bees" will be the next volume of the "International Scientific Series," and is now in press, to be very shortly issued. It will contain much new, fresh, and entertaining matter on a subject always full of interest. Sir John has been many years a close observer of the habits of these little creatures, and his volume will therefore not be a second-hand compilation, but an original contribution to the most romantic aspect of natural history.

THE entertaining sketches entitled "The Mountains of the Moon"; or, Chronicles of Hakim Ben Sheytan, concerning a curious African people, of which we have printed some representative installments in the "Monthly," is now being copiously illustrated for separate publication in a volume.

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History and Present Condition of New Orleans, Louisiana, and Report on the City of Austin, Texas. By George E. Waring, Jr., and George W. Cable. Pp. 99.

POPULAR MISCELLANY.

American Forestry.—An American Congress of Forestry was held in Cincinnati, beginning April 25th, of which the Hon. George B. Loring, Commissioner of Agriculture of the United States, was chosen President for the year. Ten State and Provincial organizations, one of which embraces the Canadian Provinces, were recognized, and sections were constituted, as follows: A. Uses of Forests; Dr. Franklin B. Hough, President. B. Conservation of Forests; Dr. John A. Warder, President. C. Influences of Forests, Injurious and Beneficial; Professor William Saunders, President. D. Educational Means; Professor N. P. Egleston, President. Professor William Saunders, of London, Ontario, read a paper on "Insects affecting Forest-Trees," in which he considered the various means of preventing and remedying insect depredations. Dr. George Vasey, of Washington, D. C., read a paper on "The Distribution of Conifers in the United States," and was followed by a discussion on resonant trees, in which the American cypress was declared to be far superior for musical instruments to any foreign wood. Mr. Hough gave an account of what had been done by the State of New York in the matter of the Adirondack Park, after which resolutions were adopted approving the policy of establishing the park, and recommending the adoption of similar measures by other States. Mr. Verplanck Colvin presented a paper on "The Decay and Preservation from Decay of Wood," in which the merits of several preservative substances were considered. Professor Lane read a paper on "The Importance of Experimental Stations of Forestry," and the Congress recommended the establishment of such stations, to be under the care of the agricultural colleges, with a central station. In a paper on "The Profits of Durable Trees," Dr. A. Furness, of Danville, Indiana, showed that an investment of $50 for one acre of land and $25 for tree-plants had returned him in sixteen years a clear profit over all expenses and taxes of $1,048. Mr. C. David, of Madison, Indiana, read a few notes "On the Natural Growth of Forest-Trees" which had given him in about thirty years, upon an originally bare prairie, a wood of

timber-trees from twelve to sixteen inches in diameter. Dr. F. B. Hough stated that a journal devoted to the interests of forestry would be begun soon, to be edited by himself, and published by Robert Clarke & Co., of Cincinnati. Committees were appointed to report on the importance of experimental forest stations; to suggest a plan for the prevention of the destruction of forests by fire and cattle; to report on the importance and necessity of State commissions of forestry; on forest-culture, and on forestry schools. The next meeting was appointed to be held at Montreal, Canada, August 21st and 22d of this year, two days before the annual meeting of the American Association for the Advancement of Science, when reports from these committees are expected. One of the days of the convention was styled "Arbor Day," and was devoted to the planting of trees in the public squares and Lincoln Park. A large number of the trees were named in honor of public men and distinguished citizens, etc. This, though not of particular practical bearing, tends to awaken interest in a cause that needs such awakening sadly enough.

Sound-Shadows in Water.—Professor John Le Conte has described in the "American Journal of Science" a course of investigations, which he has made with the assistance of his son, on sound-shadows in water. It is probably within the experience of all that more or less perfect sound-shadows are thrown by hills, buildings, piers, and other obstacles, to the transmission of aërial vibrations. Nevertheless, the boundaries of such shadows are so imperfectly defined that they can hardly be compared, except in a general way, with the shadows of light. Many ordinary obstacles are elastic and give passage to a part of the sound, as translucent bodies let a part of the light through; and waves are liable to a diffractive divergence, which proceeds from the secondary waves that originate at the boundaries of the obstacle and are propagated within the geometrical shadow. Lord Rayleigh refers the difference in effect in the case of sound as compared with light to the difference in the proportion of the wave-lengths of the two phenomena to the size of the obstacle. An ordinary obstacle bears an immense ratio to the length of a wave of light, but does not bear a very great ratio to the length of a sound-wave. Hence it follows, from the mathematical theory of undulations, that the waves of sound bend around obstacles, and produce more or less effect within the geometrical shadow, while light-shadows have definite boundaries, and are more sharply defined. These views appear to be confirmed by experiment; for the shadows cast by acute sounds are more distinct than those produced by grave sounds. It is also a significant fact that sound-shadows seem to be more perfect or more sharply defined in water than in air. David Colladon found this to be the case in 1826. Professor Le Conte's son, under his direction, made some experiments in this matter during the removal of Rincon Rock at San Francisco, by blasting with dynamite, in 1874. The shock produced in the water—which was felt at the distance of three hundred feet as a short concussion or click—was followed by a second shock in the air, that was heard. When the observer stood upon the top of a wooden pile, the concussion seemed to come up from the water along the cylinder of wood. A soda-water bottle was let down near a pile about forty feet from the explosive cartridge. Whenever it was left within the geometrical shadow of the pile from the cartridge, it was not hurt by the explosion; whenever it was placed outside of the shadow it was shivered to atoms, and this whether it was filled with water or with air. In other experiments stout glass tubes firmly adjusted to a frame-work supporting them, were let down horizontally so as to lie across the piles. In every case the shock of the explosion shivered the parts of the tube that projected on either side of the posts, and left the part within the shadow uninjured. The boundaries between the broken and the protected parts of the glass were sharply defined. The same effects were produced when the tubes were put twelve feet beyond the pile. Professor Le Conte explains these phenomena by endeavoring to show that the sound-shadows are more distinct in water than in air because the sound-waves are shorter in that medium. The character of the explosion also probably has much to do with the nature of the effect: the

sharp, sudden detonation of nitro-glycerine is calculated to generate shorter waves than a more deliberate explosion. This view is confirmed by the fact that, when an extremely disastrous explosion of nitro-glycerine took place in San Francisco in 1880, a violent concussion was felt in the University buildings, three miles away, while no aërial shock was felt at Professor Joseph Le Conte's house, eight hundred and ninety feet farther off, but within the geometrical shadow of one of the buildings. The sound-wave coming by the air was completely cut off by the acoustical shadow cast by the intervening structure. This would not have been the result in the case of ordinary sounds.

The Salmon-Disease.—Professor Huxley recently read a paper before the Royal Society on the disease which prevails occasionally among the salmon in North America and Siberia, in which he reviewed the results of the commission that was appointed in 1878, when the disease raged in the Solway district, to investigate its nature. The evidence taken before the commissioners leaves no doubt that the malady is to be assigned to the diseases caused by parasitic organisms, and that it is a contagious and infectious disease of the same order as ringworm, the muscardine among silk-worms, and the potato-disease, and is the work of a minute fungus. In fact, the *Saprolegnia* which causes it is an organism closely allied to the *Peronospora*, which is the cause of the potato-disease. One distinction may be marked between them, that the *Peronospora* are parasites depending altogether upon living plants for their support, while the *Saprolegnia* are essentially saprophytes, that is, they ordinarily derive their nourishment from dead animal and vegetable matters, and are only occasionally parasites upon living organisms. The zoöspores of these plants, diffused through the water, germinate and produce a mycelium similar to that from which they started as soon as they reach the healthy skin of a salmon. Professor Huxley experimented in inoculating the bodies of dead house-flies from the diseased salmon-skin, and in a few hours saw the bodies completely taken possession of by the white filaments of the fungus; it was proved to him that the pathogenic *Saprolegnia* of the living salmon may become an ordinary saprogenic *Saprolegnia*, and, *per contra*, that the latter may give rise to the former. Hence the cause of salmon-disease may exist in all waters in which dead insects infested with the *Saprolegnia* are met with. The *Saprolegnia* do not appear to be found on decaying bodies in salt-water. We must, therefore, "look for the origin of the disease to the *Saprolegnia* which infest dead organic bodies in fresh waters. Neither pollution, drought, nor over-stocking, will produce the disease if *Saprolegnia* are absent," although they may favor the conditions on which its spread depends. Professor Huxley also concludes that the chances of infection for a healthy fish entering a river are prodigiously increased by the existence of diseased fish in that river, insomuch as the bulk of *Saprolegnia* on a few diseased fish vastly exceeds that which would exist without them. Hence, "the careful extirpation of every diseased individual is the treatment theoretically indicated; though, in practice, it may not be worth while to adopt that treatment."

Catalogue of Scientific Periodicals.—Dr. H. C. Bolton, of Trinity College, is preparing for the press his long-delayed "Catalogue of Scientific Periodicals," which will appear in the octavo series of the Smithsonian Institution. The catalogue is intended to embrace independent journals of pure and applied science, published in all countries, from 1665 to 1880; so far as possible, minute details will be given concerning changes of title, sequence of series, editorship, and date of publication. The arrangement of titles will be strictly alphabetical, but periodicals having different names at different periods will be grouped together under the heading of the first or earliest title of the series, cross-references being made in all cases. A peculiar feature of the catalogue is presented in synoptical tables containing the dates of publication of each volume of the periodicals named, exhibited by a method slightly modified from the plan originated by Professor James D. Dana, and is described in his "System of Mineralogy" (page 34, foot-note). Only a limited number of the periodicals can be en-

tered in the synoptical tables, as preference is given to those which were published during a long series of years, or were issued very irregularly. The publication of the data contained in these tables was at one time abandoned on account of supposed typographical difficulties, but these have been overcome. The catalogue does not embrace transactions of learned societies, these being found in the admirable "Catalogue of Scientific Serials," by Mr. S. H. Scudder; but it does embrace every branch of applied science, including engineering, architecture, chemical technology, geography, ethnology, agriculture, horticulture, telegraphy, meteorology, etc. More than twenty languages are represented in the work, which it is hoped will be completed before the close of the year.

Sioux Superstitions.—Mr. H. C. Yarrow has communicated to the Anthropological Society of Washington, D. C., some observations by Mr. William E. Everett, a Government scout at Fort Custer, on some superstitions of the live Indians. The Sioux believe that when they die they go directly to the "Great Spirit's Big Village," having to cross a long divide, and perhaps fight the spirits of their dead enemies on the way; for this reason they want their best horses killed with them, and their arms put by their side. Reaching their paradise, they are received by their friends and relatives and escorted to a fine lodge, where they meet their wives and children that have gone before; all their war-horses that have been killed in battle reappear before them; if they have been maimed in war, their missing members immediately return to them; if they have mutilated themselves greatly for some friend or relative, that person comes to them and embraces them, and makes them large presents; and they find themselves encamped amid most delightful surroundings. Their idea of sickness is that a bad spirit of one of their enemies has entered the sick person, and must be driven out by noise; and a great uproar is made, while the invalid is made to inhale the smoke of sweet grasses and herbs to assist in the exorcism. Bad spirits are believed to be sometimes sent back to earth in the shape of some animal, and Indians often fancy that they can talk to their friends under such forms. Mr. Everett once saw Sitting Bull making motions with his hands, and talking to a large wolf, which apparently understood what he said, "for whenever he would make the sign for 'Do you understand?' the wolf would throw up his head and howl." The chief told Mr. Everett that he was making medicine to find where the main herd of buffalo were, and whether it would rain or snow before the hunters got back; and he said the wolf was the spirit of a great hunter, and always gave him warning whenever there was any danger close at hand, and told him where the buffalo were to be found. He also repeated some predictions the wolf had made to him, which seem to have been afterward exactly fulfilled. A remarkable superstition prevails with relation to the white-tailed deer, and is so strong that an Indian can seldom be induced to shoot one of those animals. They believe that the deer embodies the spirit of a woman, who, if it is killed, will appear before them and kill them, or make their life a torture. Mr. Everett is acquainted with several stories of Indians who started out, in spite of the superstition, to hunt the white-tailed deer and did not return, but who were afterward found, by their friends going out to search for them, lying by the side of a dead deer strangled, with the marks of a woman's hand on their throat, and a woman's feet on the ground. One grim story of this character, which he repeats with its particulars, relates to six young men who went out together and shot six deer, and were found strangled, with marks of fingers on their throats, and horrified looks, as if they had seen something awful. A curse was pronounced upon the spot where the tragedy happened, by the oldest man of the tribe, which was said by the Indians to have been fulfilled to the letter.

What are Sun-Spots?—Opinions respecting the nature of the sun-spots vary widely. Secchi thought they were clefts filled with metallic vapors; Weber and Kirchhoff, that they were clouds of smoke; Reis, that they were clouds of vaporized oxyhydrate of iron; and Faye, Zöllner, Gautier, Spiller, and Spörer, that they were a dross formed by a cool-

ing of the sun's fiery matter. None of these theories is fully satisfactory. The hypothesis of clouds of smoke hardly agrees with the immensely high temperature we have to ascribe to every part of the sun's surface, and the supposition of a dross would require a greater degree of cooling than could possibly take place there. Herr Edmund von Ludwighausen Wolff has advanced the theory in "Kosmos" that the spots, instead of being cooler, represent parts of the sun that are vastly hotter than the rest of its body; that is, that they are regions in which all the heat-movements have reached the intensity of the ultra-violet and invisible rays; consequently, they appear dark. Herr Wolff remarks that Secchi's observation that the spots gave out not less but more heat than the rest of the sun's surface, and Fraunhofer's that the forces that produce the spectrum-lines appear to be more active in the spots, and the fact that flashes of light are frequently seen to spring up from the midst of them, are contradictory to all previously received theories, but agree fully with that which he proposes, and are clearly explainable by it.

The Laws of Rain-fall.—Professor E. Loomis has prepared, in aid of his studies of the laws affecting the amount of rain-fall at different places, a graduated table of the average annual rain-fall at more than seven hundred points. Of two hundred and four stations at which the mean exceeds seventy-five inches (rising from this amount to 492·45 inches at Cherapunji, Assam), some are elevated more than two thousand feet above the sea, and nearly all are within one or two hundred miles of elevated mountains. Rain chiefly occurs when the wind from the ocean is blowing toward the mountains, and the extraordinary rain-fall at most of them is probably due to the influence of the mountains, by which the wind is deflected upward to such height that a considerable part of the contained vapor is condensed by the cold of elevation. The cases in which the rain-fall is excessively deficient are, on the other hand, those of places in which nothing exists that may cause an upward current of air. Another cause of deficient rain-fall, frequently exemplified, is the descent of a current of air which has been forced up to a great height and suffered condensation of its vapor, after it has crossed the mountain, by the influence of which it has been raised, when its temperature rises and it becomes dry. Such effects are produced by the Rocky Mountains on the plains east of them and by the Himalayas on the Desert of Gobi; and the operation of these two causes will assist in explaining most of the rainless districts of the globe. Other influences modifying the amount of rain-fall are, the meeting of the northeast and southeast trade-winds, which results in a great rain-belt surrounding the globe; the irregular barometric depressions of the middle latitudes, indicating frequent storms; proximity to the ocean, especially when the prevalent wind comes from the sea; and the projection of capes and headlands into the ocean, which contribute to frequent rains. Uniformity in the direction of the winds throughout the year, such as prevails in the trade-wind regions, obstruction of the free movement of surface-winds by mountains, remoteness from the ocean measured in the direction from which the prevalent wind proceeds, and high latitude, tend to produce a dry climate. These principles do not seem to be fully borne out by the phenomena of rain on either side of the Alleghany Mountains, but we have not yet systematic enough or careful enough observations to enable us to determine what is their real influence. Mount Washington, in New Hampshire, exerts a marked influence. The mean annual precipitation there is seventy-seven inches, while in the surrounding districts it is only forty inches.

Improved Sanitary Condition of London.—The report of the English Registrar-General for 1880 completes the fourth decade of reports since the weekly return of that officer was first published. It shows that the death-rate in London for the year (taking the population of the metropolis as given by the last census) was not more than 21·5 per thousand inhabitants, than which a lower death-rate has been returned in only three of the last forty years. The decade closing with 1880 was one of lower mortality in London than any of the three decennial periods for which trustworthy statistics are available, the rate having been

22·4 for 1880, and having ranged from 23·7 to 24·9 in the three decades from 1841 to 1870, and averaged 23·4 during the whole period. The health of London, which was practically stationary during the thirty years ending with 1870, showed a marked improvement during the following ten years; and it may be estimated that at least 70,000 persons were living within registration in London at the end of the ten years who would have died had the mean death-rate of the preceding thirty years been maintained. Dividing the ten years into two periods of five years, the death-rate appears to have been considerably lower in the later than in the earlier period. These facts afford strong evidence of the efficacy of the sanitary efforts of late years in the face of the increasing density of the population, which has, of course, worked against them. This ascription of improvement to the effect of sanitary measures is justified by the fact that the most marked decrease in mortality is in that from zymotic diseases. The average annual death-rate from fever fell from 0·92 per 1,000 during the first three decades of the forty years to 0·37 per 1,000 in 1871–'80. The rate of infant mortality has not, however, diminished to a corresponding proportion with the mortality from other classes of diseases.

The Aquarides, or July Meteors.—M. Cruls has communicated a notice of the meteors which the earth meets between the 25th and 30th of July, called *Aquarides*, because they appear to radiate from a point near δ Aquarii, of which regular observations have only recently been made under favorable conditions. The possibility of the earth meeting at a point in its orbit one or more currents of asteroids is very admissible. Each of these currents might be defined by its proceeding from distinct centers of emanation which may be determined by the crossing of the trajectories; but, to give a character of certainty to the existence of these centers, the determination should rest upon the definition of an adequate number of trajectories. If the existence of a considerable number of radiant points should be verified by continued observations, the phenomena would lose the character which a few trains isolated and distributed after a certain manner in space would present, and would assume that of an intricacy of asteroidal currents, compelling the admission that the infinite multitude of corpuscles occupies an immense zone analogous to the zodiacal light, and possibly having a certain connection with it. M. Cruls believes without doubt that the zodiacal light extends beyond the orbit of the earth, at least in certain directions; while he was observing the meteors in July, he saw the zodiacal light at one o'clock in the morning distinctly projected upon the zenith, and extending toward the eastern horizon; the earth was at that moment within its limits. Three astronomers and three pupils participated in watching the meteors at Rio, from the 25th to the 30th of July. They counted 2,710 meteors, and estimated that five per cent of the whole number escaped observation. It was manifest to all the observers that ninety per cent of all the paths of the meteors intersected each other in the neighborhood of Fomalhaut. The horary means increased fast from the hours of evening till those of morning, and exhibited a remarkable incandescence near sunrise. This seems to indicate that the swarms of meteors move in an opposite direction to the earth; for in that case, the movement of the earth at sunrise being directed toward that point in the ecliptic which is on the meridian, the meteors would then enter the atmosphere under more favorable conditions of speed than at any other hour of the night.

Piseco Lake-Trout and T Lake Falls.—Piseco Lake, in the Adirondacks, formerly the fishing-grounds of the once famous Piseco Club, was noted in the earlier days of its frequentation for the wonderful catches of trout it afforded. According to the statement of the Rev. Henry L. Ziegenfuss, in "Forest and Stream," an average of less than six men fishing from the club-house at Walton Lodge, for an average of less than nine days annually, succeeded in capturing in nine years—1842 to 1850—more than three tons of trout. The largest trout ever taken from the lake—which was called for distinction the "Emperor"—was caught on the 24th of June, 1842, and weighed twenty-six pounds and eight ounces. Another fish weighed twenty pounds and a quarter, and

measured three feet, less half an inch, in length, and two feet, less half an inch, in circumference. In June, 1847, the president of the club killed a red-fleshed lake-trout that weighed twenty-four pounds, the largest that was ever taken there by trolling. Within eight miles of Lake Piseco is T Lake, whose waters flow down the mountains toward West Canada Creek over a fall of nearly seven hundred feet, into the pool called "Snowstorm's Delight." In midsummer but little water comes down from the lake, but in spring and fall immense volumes thunder over the height with a roar that is heard at Piseco. Many extravagant statements are current respecting the height of the falls, but the matter has been partly settled by the measurements of Colonel J. T. Watson, of Clinton, New York, made in 1876. The swift rapids at the top of the falls are one hundred feet in length; the sharp pitch three hundred and ninety feet, and the almost perpendicular fall below two hundred feet, giving a total of six hundred and ninety feet. The falls are thirty feet wide at the top and three hundred feet at the bottom.

The Teleradiophone.—M. Mercadier, the French electrician, has ingeniously adapted the photophone to telegraphy. When, in working with the photophone, the ray of light striking upon the selenium receiver is eclipsed many times in a second, a continuous hum is produced, and this may be broken up into signals by varying the intervals between the intermissions, so that a kind of Morse alphabet can be played upon the instrument. An arrangement for producing signals of this kind is attached to the transmitting instrument, when the signals are sent along the line to a telephone at the other end. No gain over the ordinary telegraph is realized by such an arrangement, but, by multiplying the number of transmitters at one end and the number of telephones at the other end, it can be made to admit of several different messages being sent along the same wire at a time, and of sending messages at once from opposite ends of the wire without confusion. In order to give the multiple messages effect, it is only necessary to rotate the eclipsing wheels, which act upon the several selenium receivers at different speeds, so as to produce notes of different pitch in the receiving telephones, and to fit each resonator so as to enhance a particular note. Then, although the complex current flows through all the telephones in turn, each telephone will only render to the ear of the clerk the particular note for which he listens, and the makes and breaks of that note will be the message.

Origin of the Astronomical Symbols.—Every one who consults an almanac is acquainted with the curious figures that appear in its pages as symbols for the planets and for celestial phenomena—the only real hieroglyphics which survive in current use to our day—but few, probably, have examined into their origin. Modern text-books on astronomy do not condescend to discuss such matters, but the books of the two former centuries gave full explanations on these as well as on some other points, which the school-room science of to-day is too dignified to consider. Such books were Lalande's "Astronomy," in French; Long's, in English; and Riccioli's "Almagestum Novum," in Latin. Lalande shows that ☿, the symbol of Mercury, is derived from the caduceus, the serpent-wreathed mace of the Greek and Roman divinity; ♀ is a hand-mirror, the most appropriate symbol of Venus, the goddess of beauty; ♂, a lance, nearly covered by a buckler, which it most became the god of war, whose planet, Mars, it represented, to carry; ♃, a capital Greek zeta, the first letter of the name of Zeus, or Jupiter, re-enforced by an intersecting stroke; ♄, the sickle of old Father Time, Chronos, or Saturn; and ☉ and ☽, figures of the disk of the sun and of the new moon. Huet gives the same explanation in his notes on Manilius, and Long gives a series of artistically designed pictures of the objects themselves, from which the figures are derived. The symbols for the sun and moon are very ancient. They occur on the Egyptian monuments, and are mentioned by Clement of Alexandria in the second century. The others are of comparatively modern date, and are not so old even as the Arabian manuscripts. They were invented by the astrologers of the middle ages, and are said by Humboldt to be not older than of

the tenth century. The sign for the earth, ♁, a globe surmounted by a cross, indicating its Christian origin, may be traced to about the sixth century. Of the recently discovered planets, the sign for Uranus, ♅, is a modification of the initial H of Herschel; and that for Neptune, ♆, is derived from the trident of the sea-god. The attempt to give similar symbols to the smaller planets was abandoned after they began to be too numerous to be distinguished in this manner.

Obesity and its Treatment.—According to the observations published by M. de Saint-Germain, in the "Union Médicale," the great danger to be feared from obesity lies in the direction of lesions of the heart. Considerable differences exist relative to the influences of sex on the liability to the affliction, but M. de Saint-Germain believes that women are the more liable to it, and that in proportion as they are addicted to alcoholism, prostitution, or inactivity. It may be developed at any age, even as early as two years; M. Hillairet recently exhibited at the Academy of Medicine a little girl six years old who was wonderfully fat. Among the causes of obesity are mentioned excess of food and of alcoholic drinks, too much sleep, and occasionally marriage. Widowhood, which makes men fat, appears to have the contrary effect on women. M. de Saint-Germain illustrates his method of treatment by citing the example of one of his best friends—who was most probably himself. Having grown to the weight of two hundred and thirty pounds, he tried to train himself down by the regulation method of treatment, and in six weeks lost twenty-nine pounds and all his strength. He then stopped, recovered his weight and his health, and suffered no particular change for eight years. Then he took to horseback-riding, gymnastics, and fencing, varying his exercises occasionally, but always keeping them up actively, in the early morning hours. To these he added a severe regimen; no breakfast after his fatiguing exercises, but a cigar to sooth the stomach. Later a breakfast of two boiled eggs, a cutlet with salad and fruit, coffee without sugar or spirit, no bread or wine, but water or tea without sugar to drink; for dinner, no soup, a plate of meat, a dish of green vegetables, fruit, no bread or wine; no dining in the city; absolute self restraint. The result was a fall of his weight to two hundred and twelve pounds, and increased vigor.

An Ideal Jelly-Fish.

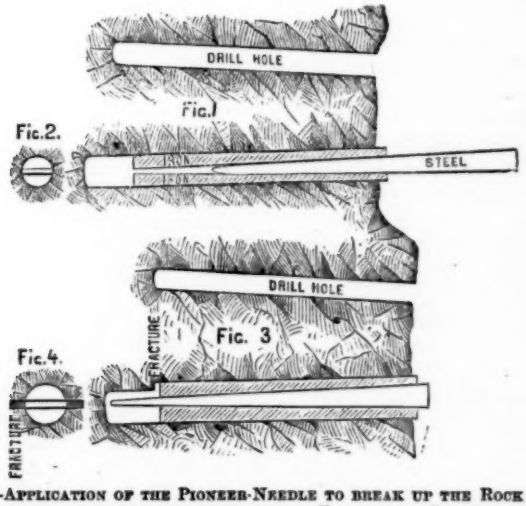
A jelly-fish swam in a tropical sea,
And he said: "This world it consists of ME;
There's nothing above and nothing below
That a jelly-fish ever can possibly know,
Since the highest reach we can boast of, sight,
Is only the vaguest sense of light;
And we've got, for *the final test* of things,
To trust to the news which one feeling brings.
Now all that I learn from the sense of touch,
Is the fact of *my feelings* viewed as such;
But to think these have an external cause
Is an inference clear against logical laws:
Again, to suppose, as I've hitherto done,
There are other jelly-fish under the sun,
Is a poor assumption that can't be backed
By a jot of proof or a single fact:
In short, like *Fichte*, I very much doubt
If there's anything else at all without;
And so I've come to the plain conclusion,
If the question be only set free from confusion,
That the universe centers solely in me,
And if I were *not* then *nothing* would be!—"
Just then a shark, who was passing by,
Gobbled him up in the twink of an eye,
And he died with a few convulsive twists,
But, somehow—the universe still exists!

GRANT ALLEN.

Reciprocal Parasitism.—M. Maxime Cornu has taken notice of a prolongation of the vegetative activity of the chlorophyl-cells occurring under the influence of a parasite. M. Schwendener has affirmed that lichens are really fungoid parasites on algæ, which they envelop with their filaments and at the expense of which they live; and his view has been confirmed by the investigations of Rees, Bornet, and Stahl. The principal argument which has been opposed to this theory is based on the difficulty of explaining how the alga continues to live, grow, multiply, and even acquire new vigor, instead of perishing in the toils of the parasite. M. Van Tieghem supposes, to explain

this singular circumstance, a special form of parasitism, which he calls reciprocal parasitism. It may, perhaps, be illustrated by the case of the leaf of the maple, which is frequently attacked at the end of the summer by an erysiphus, that occupies the lower surface and fruits there. In the fall the leaves change color and drop off, but the spots occupied by the erysiphus remain green, and so continue, a spot distinct from all the rest of the leaf, for weeks. A similar reciprocation may take place between the algoid and fungoid parts of the lichen.

A Mechanical Rock-Excavator.—By the aid of perforators, worked by compressed air, it has been possible to complete in a few years works of subterranean excavation like the tunnels of Mont Cenis and Mont St. Gothard, which would formerly have occupied several generations of miners. Hand-drilling can be dispensed with when such perforators are used, for the perforator itself makes the hole destined to receive the powder by which the rock is blown up, and the miner has nothing to do but to pick up the pieces. A full solution of the mechanical operation of boring is thus obtained, and a self-acting ventilation of the shafts and the removal of all noxious vapors are secured at the same time. Till recently it was not practicable to apply the perforators in coal-mines charged with explosive gases, for such mines had to be worked without using powder. Two French engineers, MM. Dubois and François, have resolved this difficulty by the construction of an apparatus which they call a *bosseyeuse*, or, as we might call it in English, a pioneer-drill. Its principal feature is a kind of needle-wedge which is made under the action of the perforator to enter the hole made by the drill and break the rocks up by the force of pressure, without throwing out the fragments as powder does. This apparatus has been used in several gas-infected mines in the Belgian coal-basin, with a considerable consequent diminution in the frequency of



FIGS. 1 TO 4.—APPLICATION OF THE PIONEER-NEEDLE TO BREAK UP THE ROCK IN THE HOLE THAT HAS BEEN ALREADY MADE BY THE FOIL OF THE PERFORATOR.

explosions. The powder, if that is used, is introduced when the hole excavated by the perforator has reached a depth of about twenty-seven inches; or, if the mine contains explosive gases, the needle-wedge is substituted for powder. This apparatus, which is represented in the figures (1 to 4), consists of two bars of iron, shaped like segments of a circle, and touching by their ends, the union of which constitutes a cylinder hollowed along its axis with a conical hole. The section of the two segments is of the same size as the drill-hole, so that they fill it completely when inserted in it. As soon as the drill-hole has been hollowed to a sufficient depth, these two bars are in-

serted in it, and a conical steel needle-drill is introduced into the central hole of the metallic cylinder thus formed. The piston-head of the perforator is then made to strike upon the head of the needle, so as to drive it in like a wedge and cause it to force the two segments apart and split the rock. As many holes may be made as are necessary to break the rock up, and this depends much upon its hardness. Fig. 5 represents a sec-

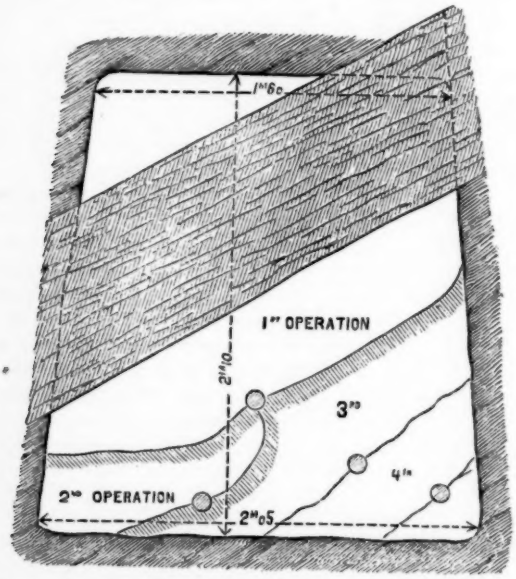


FIG. 5.—SECTION OF A GALLERY UNDER A COAL-MINE, INDICATING THE HOLES TO BE BORED BY THE PERFORATOR, SO AS TO BREAK UP THE STERILE ROCK IN FOUR SUCCESSIVE OPERATIONS.

tion of the chamber of a coal-mine, and indicates the position of the holes that have to be drilled to break up the rock in four successive operations. The inventors of this apparatus claim that rock can be broken up with it in veins of the average thickness almost as fast as with gunpowder.

Transmission of Vibrations.—The Transactions of the Seismological Society of Japan contains an account of experiments by Professor H. M. Paul, in Washington, D. C., on the transmission of vibrations from railroad-trains through the ground. Cups containing mercury were fixed at four stations, at distances of from 0·29 to 0·93 of a mile from the railroad, in which the amount of disturbance caused by vibration was ascertained by noticing the displacements of the reflected image of the pole-star. The character of the effects varied according to the distance of the station from the train, the nature of the ground at the station, and the kind of train, but they were distinct. At one of the stations the communication of vibrations, which were limited to a shallow depth, appeared to be interrupted by the intervention of a ravine. The effect of carriage-driving on a public road was also observed. A hack carrying four persons and drawn by two horses, about four hundred feet away, caused a temporary shaking of the mercury whenever a wheel struck a stone or hollow; and a similar effect was produced while the carriage was crossing a small wooden bridge at about five hundred feet; but no serious continuous disturbance was perceived till the carriage approached within two or three hundred feet of the instrument.

The Systematic Position of the Brachiopoda.—In the "Jenaische Zeitschrift für Naturwissenschaft," Jena, 1881, Dr. Oscar Hertwig and Dr. Richard Hertwig, the eminent embryologists, recognize the work of

Edward S. Morse on the Brachiopoda as follows. Having made certain comparisons, they say: "After these analyses, it is self-evident that the brachiopods must be distinguished from the mollusks, and that the two represent perfectly different types of development. It is the merit of Steenstrup to have first recognized this, and indeed, as early as 1847, to have sought a connection of the brachiopods with the annelids. Independently of him, Morse has pursued the same road, and one may say decided the question by comparing, with great ingenuity and to the minutest details, the anatomy of the brachiopods with that of the worms and the mollusks, and has in this connection proved throughout their difference from the mollusks and agreement with the annelids." Gegenbaur also assumed the position of Steenstrup and Morse, and remarks in the second edition of his "Grundzuge" that the brachiopods have little more in common with the mollusks than the possession of a shell quite different from the housing integument of the latter, and form a small and sharply distinguished division, the origin of which may be traced back to the stem of the worm and specially of the chætopod.

Death of Professor William B. Rogers.—Professor William B. Rogers, ex-President of the Massachusetts Institute of Technology and one of its founders, died very suddenly of apoplexy, May 30th, during the exercises of the graduating class of the institution, which he was attending. He had begun making an address, and was reviewing what the institute had accomplished, when he was attacked. He was taken from the hall, and died in about twenty minutes. Professor Rogers was born in Philadelphia in 1805, and was one of four brothers, all of whom have distinguished themselves in science. He suceeeded his father, Dr. P. K. Rogers, as Professor of Natural Philosophy and Chemistry in William and Mary College, in 1829, and was Professor of Natural Philosophy and Geology in the University of Virginia from 1835 to 1853. He removed to Boston, where he had since lived, in the latter year. He was President of the Institute of Technology from 1862 to 1868, and was President of the American Association for the Advancement of Science in 1875. He was the author of works on the "Strength of Materials" and the "Elements of Mechanical Philosophy," and of many scientific papers. A portrait and sketch of Professor Rogers were given in "The Popular Science Monthly" for September, 1876.

The Mysterious Volcano of Apo.—The Governor of Davao, Mindanao, Philippine Islands, recently ascended a remarkable volcano called Apo. An expedition to the mountain had often been contemplated before, but had been prevented, partly by the unexplored and difficult character of the country, partly by the opposition offered by the natives, who, though nominally Mohammedans, believe that the summit of the mountain is inhabited by a demon to whom they are accustomed to make offerings when they think he is angry with them, or when they wish him to allow them to collect sulphur. The crater of the volcano was found to be 9,970 feet above the sea, extinct, and covered with vegetation within, although the temperature of the air was but little above the freezing-point. A wide chasm on the southern slope of the mountain was the seat of numerous *solfataras*, which, furiously spitting out sulphurous vapors with a fearful smell and roar, might well inspire fear in the minds of an ignorant populace. The Tagalaya stream, which rises on the mountain, and in the rough bed of which the ascent was made, brings down lumps of sulphur. A sharp cold prevails in the crater and on the mountain for three thousand feet below it, but the lava and ashes still radiate enough heat to be perceptible, and make one warm who lies down upon them; and, perhaps, to keep up the vegetation which manages to subsist there. Two petrified tree-trunks, which were noticed during the ascent, indicate that a very different vegetation formerly existed there.

Eggs of Reptiles and Insects as Food.—The eggs, even of animals which impress us most unpleasantly, have their value as food, and seem to be capable of inspiring a relish in the palates of those who have learned to eat them. The eggs of most of the species of tortoises are excellent for eating, nutritious, and agreeable to the taste; and those

of the green turtle are held in great esteem wherever they are found. The mother-turtles lay three times a year, depositing sometimes as many as a hundred eggs at a laying, and carefully covering them up with sand, so that it requires an experienced searcher to detect them. The Indians of the Orinoco and Amazon obtain from these eggs a kind of clear, sweet oil, which they use instead of butter. About five thousand eggs are required to fill one of their jars with oil; yet so abundantly are they deposited that about five thousand jars are put up yearly at the mouth of one of the rivers; the harvest is estimated by the acre. Young eggs are frequently found in the bodies of slain turtles by hundreds, in all stages of development, and generally consisting entirely of yolk; they are often preserved by drying, and are considered a great luxury. Alligators' eggs are esteemed by the natives of the regions where those reptiles abound; and Mr. Joseph, in his "History of Trinidad," says that he found the eggs of the cayman very good. The female alligator lays from one hundred and twenty to one hundred and sixty eggs; they are about as large as the egg of a turkey and have a rough shell filled with a thick albumen. One of the lizards, known as the iguana, is capable of furnishing as many as fourscore eggs, which when boiled are like marrow. The larvæ and nymphæ of ants are considered by many people a choice relish when spread upon bread and butter, and are said to be excellent curried. In Siam they are highly esteemed, and are so valuable as to be within the reach only of the rich. In some parts of Africa, where ants swarm, they are said to form at times a considerable proportion of the food-supply. They are used in some countries of Europe for making formic acid, and are subject to an import duty. The eggs of insects belonging to a group of aquatic beetles are made in Mexico into a kind of bread or cake called *hautle*, which is eaten by the people, and may be found in the markets. They are got by means of bundles of reeds or rushes, which are put in the water and on which they are deposited by the insects. Brantz Mayer, about forty years ago, noticed men on the Lake of Tezcuco collecting the eggs of flies which, he says, when cooked in cakes were not different from fish-spawn, having the same appearance and flavor. "After the frogs of France and the birds' nests of China, I fancy they would be considered delicacies, and I found they were not disdained on the fashionable tables of the capital." According to the report of the Commissioner of Agriculture for 1870, the larvæ of a large fly which frequents Mono Lake, in California, are dried and pulverized and mixed with acorn-meal and baked for bread, or with water and boiled for soup.

Sanitary Inspection of Houses.—Mr. Lewis Angell, Sanitary Inspector of West Ham in Essex, an outlying district of London, says, in illustration of the prevalence of sanitary defects even in the best houses, and of the need of thorough inspection, that in the civic palace of the Lord Mayor of London, "three quarters of an inch of floating fungi scurf was recently found on the surface, and three eighths of an inch of mud at the bottom of the cisterns, while a bottle of water on his lordship's table contained hundreds of nematoid worms." Offensive mud and animal organisms were also found in the cistern of the Athenæum Club, St. James. We habitually defy disease when we leave the doors of our closets open and the windows shut. The reverse ought to be the practice. He believes that sanitary science should be put on a par with literary and mathematical studies in the schools, and that public and official inspection should be provided for everywhere, the expense in the care of new buildings to be met by fees charged upon the owners and builders, who expect to derive a profit from them. He commends what has been done in Chicago in the official inspection of tenements, and the official supervision of plumbing that has recently been adopted in New York.

The Screw-Propeller.—The people of Boulogne, France, have recently set up a statue of Frédéric Sauvage, to whom they ascribe the invention of the screw-propeller. He devised a means of propulsion by screws in 1832, and offered it to the French Government. A commission reported upon it that it might be employed with advantage

for small boats, but would be of no use for large vessels. The English Government tried to buy the invention exclusively for England, but Sauvage refused to sell it on such terms. It was applied to a steamer in 1841, after plans furnished by Sauvage, but the builder and engineer of the vessel took all the credit for it. After an experience in the debtors' prison, and then spending $16,000 in experiments during ten years, Sauvage passed the last years of his unfortunate life in the Picpus asylum. The priority of his invention is disputed in behalf of several Englishmen: of James Watt, who proposed to use a screw in 1770; of Edward Shorter, who patented a propeller in 1800, and applied it two years afterward; of Stevens, in the United States, who tried to drive a boat by a screw in 1804; of Trevithick, who invented a screw-propeller in 1816; and of Samuel Brown, who used one in 1827. F. Pettit Smith, to whom more than any other person we owe the use of this motor, never claimed to be its inventor, but only that he placed it in the dead-wood of the vessel. The "Revue Scientifique" claims the credit of the invention for Charles Dallery, who obtained a patent for a screw-propeller and a tubular boiler in 1803.

NOTES.

THE fifth annual meeting of the American Society of Microscopists will be held at Elmira, New York, Tuesday, August 15th, and on the three following days. Liberal arrangements have been made by the local committee for entertainment. A meeting of great interest is anticipated. A larger list of papers than on any previous occasion has been promised, and preparations have been made for a full display of instruments, accessories, and objects. Committee reports are to be made "On Eye-pieces," "On Revision of the Constitution," and "On the Question of a Quarterly Journal." Members intending to be present will please notify Dr. Thaddeus S. Updegraff, secretary of the local society, Elmira, New York; members intending to present papers or communications, to Professor D. S. Kellicott, secretary of the association, 119 Fourteenth Street, Buffalo, New York.

M. A. BLAVIER has endeavored to account for certain remarkable climatological anomalies that have been recently observed in France, by supposing that the Gulf Stream was deflected from its regular course. He observes that the sardines, which, in their regular migrations, follow exactly the course of the derivative current of the Gulf Stream, called the Rennel, have followed another route than their usual one to the ocean; also that a slight elevation of temperature has been observed in Shetland; and that an accumulation of ice has been noticed at the French station in Iceland.

M. DE LACERDA, of the Physiological Laboratory of Rio Janeiro, recommends the permanganate of potash as a sure antidote for the bite of venomous snakes. To be effective the solution of the salt should be prepared at the moment of using it; and in order that it may always be on hand, he recommends that packages be put up to be carried by persons going into dangerous spots, containing one tenth of a gramme of the permanganate, and a ten-gramme bottle. The solution should be injected with a syringe.

FROM a statement made in the French Academy of Sciences, by M. Gosselin, it appears that M. Collin, of Alfort, has found that American trichinous meat contains almost exclusively dead trichinæ, and is, therefore, not particularly dangerous.

MACGILLIVRAY, in his narrative of the voyage of H. M. S. Rattlesnake in 1852, said that he had seen the skulls of children at Cape York pressed into a conical shape by the constant manipulation of their mothers. Von Baer doubted the possibility of such an effect being thus produced. Dr. Miklucho Maclay, however, saw the pressure actually applied by the mothers at Torres Straits in 1880. He says that, during the first weeks of the lives of the children, the mothers were accustomed to spend several hours each day in compressing the heads of their children, for the express purpose of giving them a conical shape. Another kind of deformity, in the heads of the women, resulting from their habits in carrying loads, was observed by Dr. Maclay in New Guinea. The women here were accustomed to put whatever they had to carry into bags, which they supported by bands laid on their heads, a little behind the coronal suture. This practice, pursued from childhood, produced a saddle-shaped depression across the skull, which was sometimes three or four millimetres deep.

PROFESSOR E. DESOR, of Neufchâtel, Switzerland, geologist and anthropologist, and a student of glaciers and glacial geology, died in March last. He lived several years in the United States, and has left his mark on American geology and marine zoölogy.

THE National Academy of Sciences consists of ninety-five members and four honorary members, ninety-nine in all. Thirty-four live in the New England States: seventeen in Massachusetts, three in Rhode Island, and fourteen in Connecticut. Thirty-six live in the Middle States: fifteen in New York, five in New Jersey, fourteen in Pennsylvania, two in Maryland. Sixteen live in the District of Columbia. Nine live West: one in Ohio, one in Kentucky, one in Illinois, two in Missouri, four in California. Three live abroad, all being New-Englanders. One is unclassified as to residence. None live South. Total, ninety-nine.

Forty-three represent the mathematical sciences, as pure mathematics, astronomy, geodesy, engineering, physics, etc. Twelve represent chemistry; sixteen represent the geological sciences; twenty-four represent the biological sciences; four are unclassified. Total, ninety-nine.

M. PAUL BERT has been elected a member of the French Academy of Sciences, to fill the vacancy in the department of medicine and surgery caused by the death of M. Bouillaud.

M. PIOT has made experiments, under the direction of M. Laborde, to ascertain the order in which the functions of the organized tissues cease in normal asphyxia. He insists that the exact moment of death is very difficult to determine, and that we can not fix the instant when the stoppage of the heart and of respiration is definite. The mechanical movements of inspiration first cease to become apparent; then the beating of the heart becomes less frequent, but continues; the pupils of the eyes are dilated excessively, and the cornea becomes insensible. These, however, are only apparent signs of death, for dogs in which such phenomena have appeared may still be brought back to life by means of artificial respiration.

M. DE KHOTINSKY, a Russian naval officer, has been endeavoring to improve the lime-light so as to render it available for general purposes. He proposes to supply oxygen in a condensed form, and to burn ordinary gas with it in his new lamp, in which he has made a fresh adjustment of the lime or magnesia.

M. PAUL BERT, before the resignation of the Gambetta ministry, had instructed M. Dumas, permanent Secretary of the French Academy of Sciences, to draw up a list of scientific men who had died or received injuries while making experiments or researches for the advancement of science, with the view of awarding pensions to the widows and families of those who had died, and of giving substantial aid to those who survived.

M. CAMPARDOU has made some new observations on the successful treatment of apparently dead infants with baths at about 120°. In one case, an infant on which friction, inflation of the lungs, and other remedies had been tried in vain, and which M. Campardou regarded as lost, was put into water of 113°, and revived in less than fifteen seconds. The same process was applied to an infant fifteen days old, which had apparently died after a gradual decline.

M. MAREY has succeeded in obtaining photographs of birds and insects in the act of flying. He introduces the "photographic revolver" into an apparatus having a shape roughly like that of a gun, and, pointing it at the flying animal as if he were going to shoot it, he has obtained a series of impressions each of which represents a stage of the flight. The pose, which is naturally only about $\frac{1}{1000}$ of a second, has been prolonged to $\frac{1}{100}$ of a second with most satisfactory results.

THE French Academy of Sciences recently departed from its custom of giving memorial honors only to members, to pay a tribute of respect to M. Poitevin, deceased who was one of the principal contributors to the improvements in processes for multiplying photographs by which the photographic has been raised to be a real industrial art.

ACCORDING to Libanius, the term "atheists" was used as a common name for Christians by the cultivated Greeks of his period —the fourth century.

KÖNIG'S great tonometer, the unique collection of standard tuning-forks which was shown at the Philadelphia Exhibition, is still for sale, the project to buy it for the University of Pennsylvania having fallen through. "Nature" suggests that if it can not be acquired for the South Kensington collection, an effort be made to buy it for either the Cavendish or the Clarendon Laboratory.

M. C. DECHARME has given an account of hydrodynamic experiments in which he has imitated the phenomena of electro-magnetism and induction by means of liquid currents. M. Bjerkness, in his experiments performed with vibrating and pulsating bodies in still water, obtained analogous effects, but inverse, to those of electricity and magnetism. M. Decharme, using running liquids, found the analogies to be direct. He produced sonorous vibrations of greater or less pitch by turning currents of gas upon mercury, and more or less grave vibrations by directing currents of water upon a solid body. The vibrations of the former kind were carried beyond the highest, and those of the latter kind below the lowest, limit of perceptible sounds.

ADOLF ERIC NORDENSKIÖLD.